LOWER ARKANSAS RIVER BASIN TOTAL MAXIMUM DAILY LOAD

Waterbody: Arkansas River from Wichita to Derby
Water Quality Impairment: Nitrate

1. INTRODUCTION

Subbasin: Middle Arkansas – Slate

Counties: Sedgwick

HUC8: 11030013 **HUC10** (12): **01** (06)

Ecoregion: Wellington-McPherson Lowland (27d)

Drainage Area: 28.5 square miles (mi^2)

Main Stem Water Quality Limited Segments (designated uses for the main stem segment are detailed in **Table 1**)**:**

Main Stem
HUC8 11030013
Arkansas River (3)

Table 1. Designated uses for main stem segments in the Arkansas River (Kansas Department of Health and Environment, 2013).

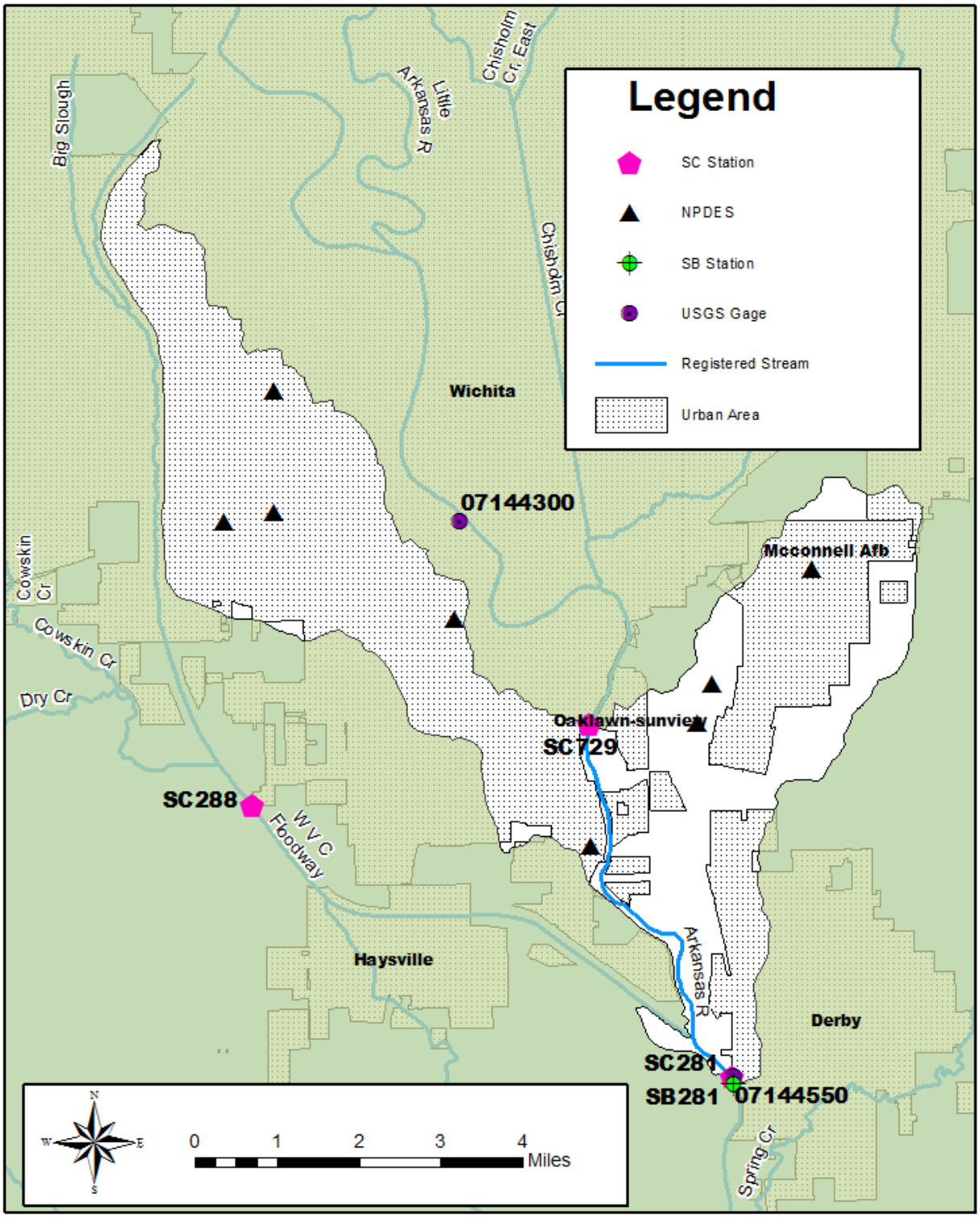
Stream	Segment	Aquatic Life	Contact Recreation	Domestic Supply	Food Procurement	Groundwater Recharge	Industrial	Irrigation	Livestock Watering
HUC8: 11030013									
Arkansas River	3	S	B	Y	Y	Y	Y	Y	Y

Definitions: S - special aquatic life use; B - primary contact recreation stream segment is by law or written permission of the landowner open to and accessible by the public; Y - use is designated

303(d) Listings:
Station SC281 (**Figure 1**), Arkansas River at Derby.
Nitrate (NO_3) Impairment, Category 5: 2014 and 2016.
Lower Arkansas River Basin Streams.

Impaired Use:
Special Aquatic Life, Contact Recreation, and Domestic Water Supply.

Figure 1. Map of watershed contributing area for Kansas Department of Health and Environment stream chemistry (SC) station Arkansas River at Derby (SC281).



Water Quality Criteria:

Numeric:

Nitrate (as N): The domestic water supply criterion is 10 milligrams per liter (mg/L; KAR 28-16-28e(c)(3); KAR 28-16-28e(e), Table 1a; Kansas Department of Health and Environment, 2015).

Narrative:

The introduction of plant nutrients into streams, lakes, or wetlands from artificial sources shall be controlled to prevent the accelerated succession or replacement of aquatic biota or the production of undesirable quantities or kinds of aquatic life (K.A.R. 28-16-28e(d)(2)(A)).

The introduction of plant nutrients into surface waters designated for domestic water supply use shall be controlled to prevent interference with the production of drinking water (K.A.R. 28-16-28e(d)(3)(D)).

The introduction of plant nutrients into surface waters designated for primary or secondary contact recreational use shall be controlled to prevent the development of objectionable concentrations of algae or algal by-products or nuisance growths of submersed, floating, or emergent aquatic vegetation (K.A.R. 28-26-28e(d)(7)(A)).

2. CURRENT WATER QUALITY CONDITION AND DESIRED ENDPOINT

Level of Support for Designated Uses under 2016 303(d):

Nitrate levels in the Arkansas River at Derby occasionally exceed the Kansas Water Quality Standards of 10 mg/L. Excessive nutrients are not being controlled and are thus impairing special aquatic life, contact recreation, and domestic water supply. The ultimate endpoint of this Total Maximum Daily Load (TMDL) will be to achieve the Kansas Water Quality Standards by reducing nitrate levels to protect full support of all designated uses and to prevent objectionable concentrations of algae. Achievement of this endpoint indicates nitrate loads are within the loading capacity of the stream, water quality standards are attained, and full support of the designated uses of the stream are restored.

Station Location and Period of Record:

Stream Chemistry (SC) Monitoring Station:

SC729: Active, permanent station at Arkansas River at Wichita, located on East 47th Street South Bridge in Wichita. Period of record: June 20, 2000 to April 24, 2017.

SC288: Active, permanent station at Cowskin Creek in Wichita-Valley Center Floodway, located on County Road Bridge 1 mile north and 1.1 miles west of Haysville. Period of record: February 6, 1995 to April 24, 2017.

SC281: Active, permanent station at Arkansas River at Derby, located on County Road Bridge at the west edge of Derby. Period of record: February 7, 1995 to April 24, 2017.

Stream Biology (SB) Monitoring Station:

SB281: Active station at Arkansas River at Derby, located on County Road Bridge at the west edge of Derby. Period of record: October 3, 1995 to October 20, 2016.

Streamflow Gage:

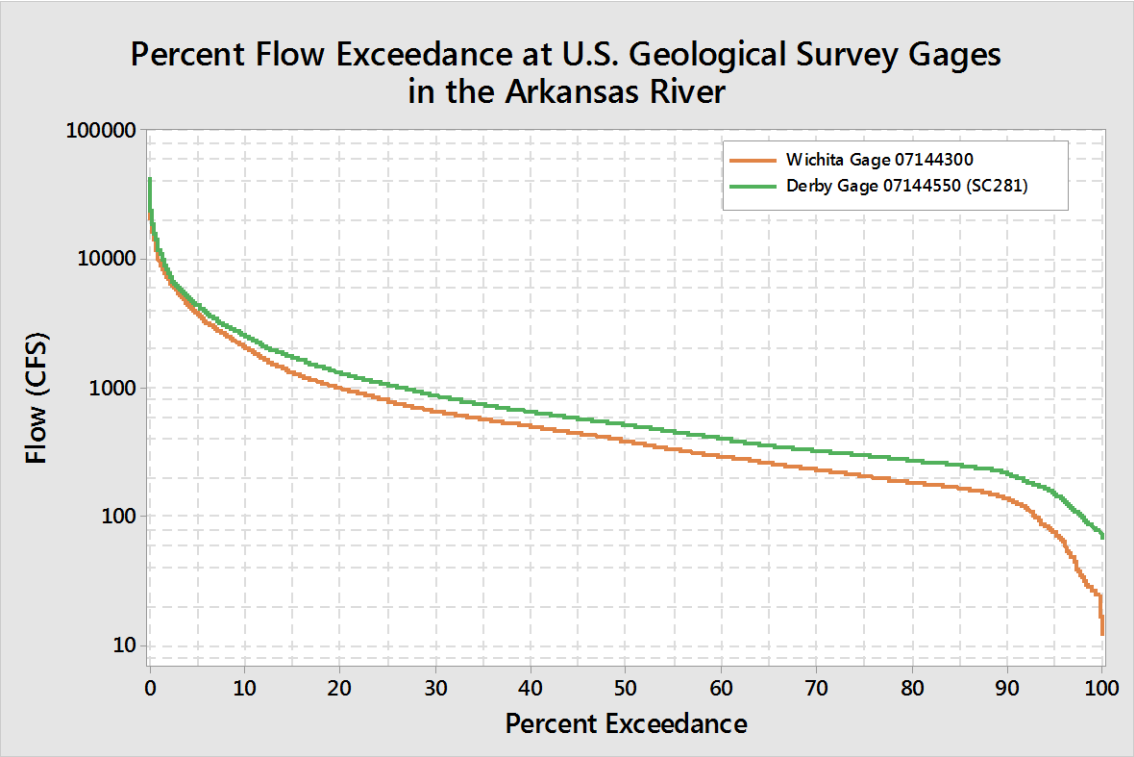
U.S. Geological Survey 07144300: Arkansas River at Wichita. Period of record: January 1, 1995 to June 30, 2017. Located near Wichita (SC729).

U.S. Geological Survey 07144550: Arkansas River at Derby. Period of record: January 1, 1995 to June 30, 2017. Located at Derby (SC281 and SB281).

Hydrology:

Flow conditions for this TMDL were analyzed using U.S. Geological Survey (USGS) streamgage data from the Arkansas River at Wichita (07144300) and Derby (07144550). Both gages have streamflow data available for the period of record January 1, 1995 to June 30, 2017. Flow duration curves for the Arkansas River at Wichita and Derby indicate increasing flow from the upstream (Wichita) to downstream (Derby) sites during all flow conditions (**Figure 2**).

Figure 2. Flow duration curve for U.S. Geological Survey gaged sites located in the Arkansas River.



Flow conditions for Kansas Department of Health and Environment (KDHE) stream chemistry (SC) stations were calculated using USGS streamgages and a watershed area ratio, where necessary (**Table 2**). The streamflow at KDHE SC station Arkansas River at Wichita (SC729) was derived from the watershed area ratio and the USGS streamflow gaging station Arkansas

River at Wichita (07144300). The streamflow at KDHE SC station Arkansas River at Derby (SC281) utilized streamflow from USGS gaging station Arkansas River at Derby (07144550).

Table 2. Flow conditions and drainage area at U.S. Geological Survey gages and Kansas Department of Health and Environment stream chemistry (SC) stations in the Arkansas River.

Stream	Station	Contributing Drainage Area (mi^2)	Mean Flow (CFS)	Percent of Flow Exceedance (CFS)				
				90%	75%	50%	25%	10%
Arkansas R at Wichita	07144300	33,227	964	139	207	391	804	2,090
Arkansas R at Wichita	SC729	33,283	965	139	207	392	805	2,094
Arkansas R at Derby	07144550/SC281	33,567	1,192	219	303	521	1,070	2,570

Long-term estimated flows for the Arkansas River can be found in **Table 3** (Perry et. al, 2004). The main tributary to the Arkansas River is the Wichita-Valley Center (WVC) Floodway, which enters the Arkansas River before Derby (SC281). The WVC Floodway is one of the largest water diversion projects in the U.S. (Guilliams, 2016). It was constructed between 1950 and 1959 by the Army Corp of Engineers to divert water from the Arkansas River, Little Arkansas River, and Chisholm Creek in order to prevent the City of Wichita from flooding, as the city had consistently done since the late 1800s. The final project consists of an 18 mile long channel with twice the capacity of the Arkansas River which comprises 50 miles of connecting channels, 100 miles of levees, and 150 control structures. The WVC Floodway has a separate assessment unit associated with station SC288 and is not assessed for the purpose of this TMDL.

Table 3. U.S. Geological Survey (USGS) long-term estimated flows for the Arkansas River and its tributary (Perry et.al, 2004).

Stream	USGS Site	KSWR CUSEGA Number	County	Drainage Area (mi^2)	Mean Flow (CFS)	Flow Exceedance (CFS)					2-year Peak (CFS)
						90%	75%	50%	25%	10%	
Arkansas R	**4313**	**110300139**	**SG**	**37,913**	**1,046**	**126**	**226**	**433**	**858**	**2,220**	**9,740**
WVC Floodway	71	11030013456	SG	199	56	3	7	17	36	83	2,290
Arkansas R	**4495**	**110300133**	**SG**	**38,003**	**1,208**	**192**	**304**	**541**	**1,110**	**2,590**	**14,200**

Definition: SG - Sedgwick

Annual mean flows at the Wichita and Derby gages are higher than median flows. Annual high mean flows occurred in 2007 at Wichita and Derby, with mean high flows of 1,798 and 2,041 CFS, respectively (**Figures 3-4**). Annual high median flows occurred in 1998 at Wichita, with a median of 981 CFS, and in 1999 at Derby, with a median of 1,160 CFS. The lowest annual flows at Wichita were in 2006 and 2012, with a mean of 180 CFS in 2006 and a median of 80 CFS in 2012. The lowest annual flows at Derby were in 2012, with a mean of 292 CFS and a median of 159 CFS. Annual flows generally coincide with National Oceanic and Atmospheric Administration (NOAA) annual total precipitation from Wichita station USW00003928; however, the highest annual precipitation occurred in 2008, and the lowest annual precipitation

occurred in 2001. Annual highest flows at both gages occurred in 1998 (**Figures 5-6**). These annual peak flows correspond to the year of "The Halloween Flood of 1998" in Wichita due to excessive and extended rainfall over a three-day period (National Oceanic and Atmospheric Administration, 2008). This highlights that precipitation intensity, as well as cumulative precipitation, can heavily influence streamflow.

Monthly mean and median flows are highest in May and June at both Wichita and Derby (**Figures 7-8**). Mean flow values during these months are skewed by high flow events that can be more than twice the median flow values. Monthly mean and median flows at Wichita and Derby are lowest in December and January. These monthly patterns correspond to seasonal variability, with high flows occurring in spring (April through June) and low flows occurring in winter (November through March), as evidenced in **Figure 9**.

Figure 3. Annual mean and median flows for U.S. Geological Survey gage 07144300 at Wichita located near Wichita (SC729) in the Arkansas River and annual total precipitation at NOAA station USW00003928 in Wichita.

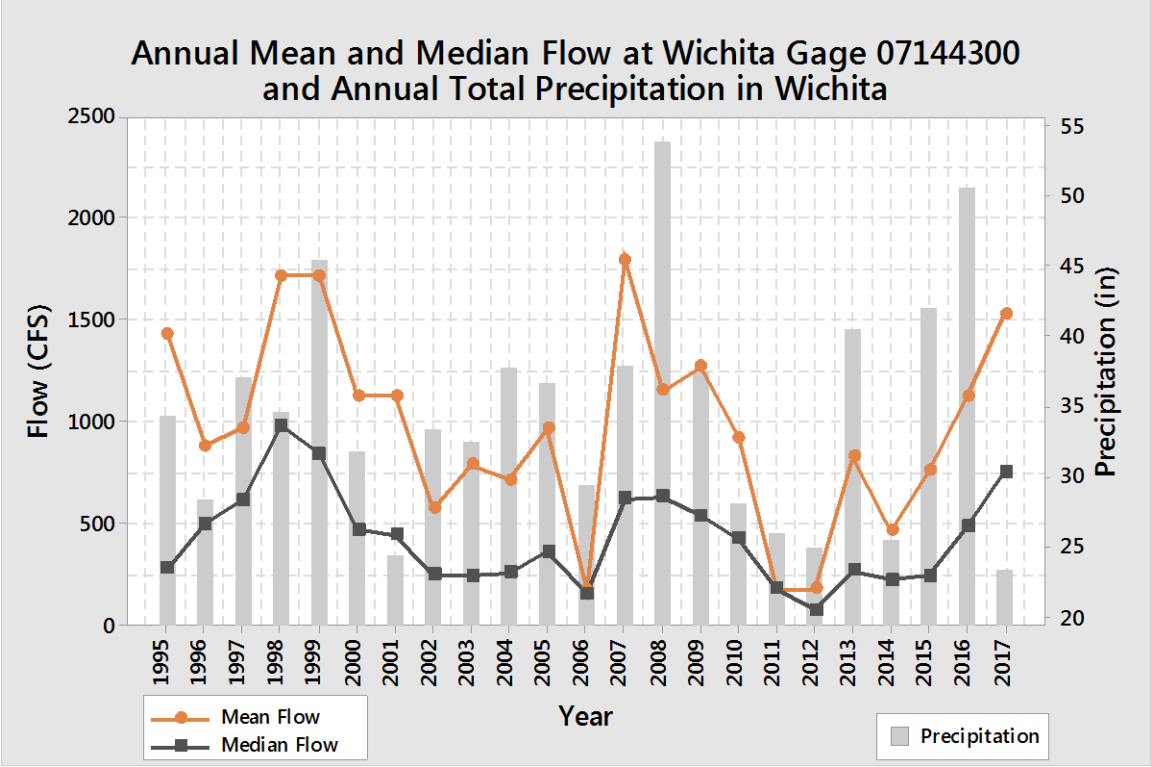


Figure 4. Annual mean and median flows for U.S. Geological Survey gage 07144550 at Derby located at Derby (SC281) in the Arkansas River and annual total precipitation at NOAA station USW00003928 in Wichita.

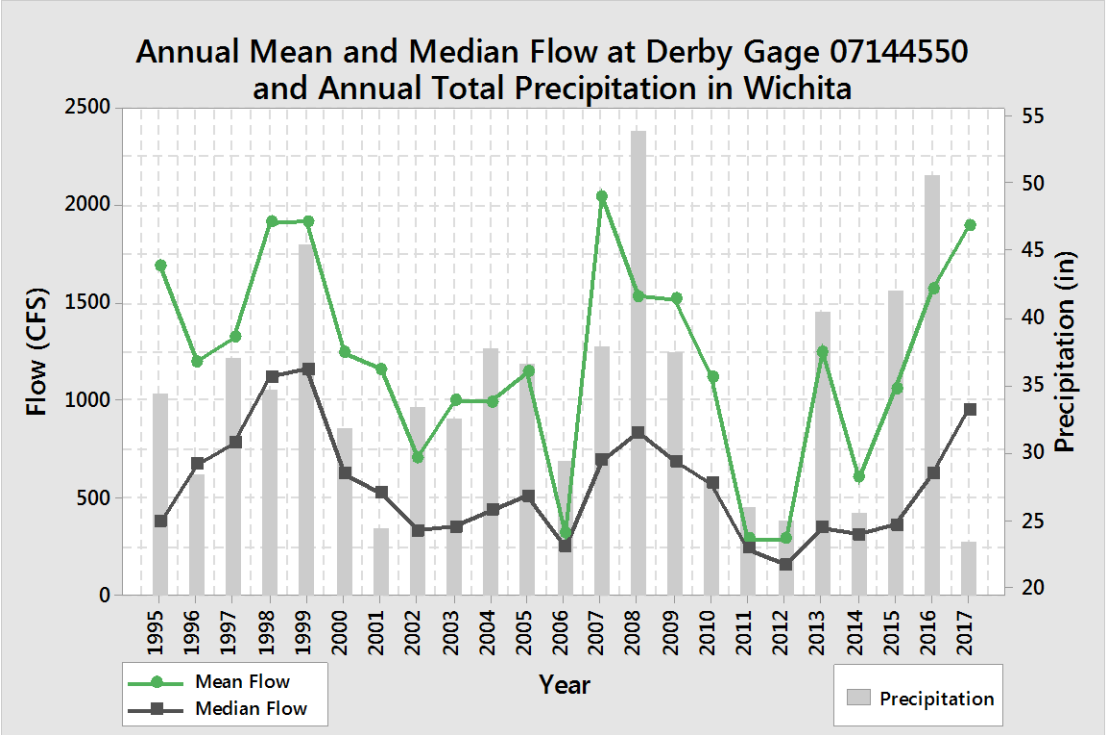


Figure 5. Annual peak flows for U.S. Geological Survey gage 07144300 at Wichita located near Wichita (SC729) in the Arkansas River.

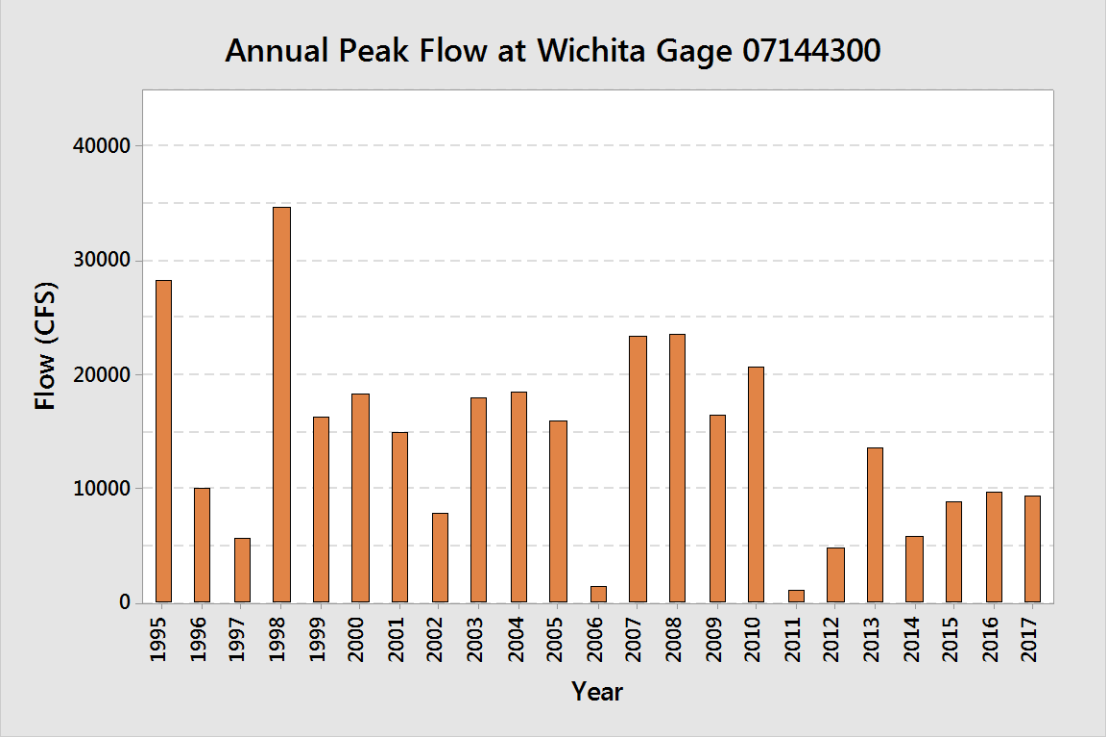


Figure 6. Annual peak flows for U.S. Geological Survey gage 07144550 at Derby located at Derby (SC281) in the Arkansas River.

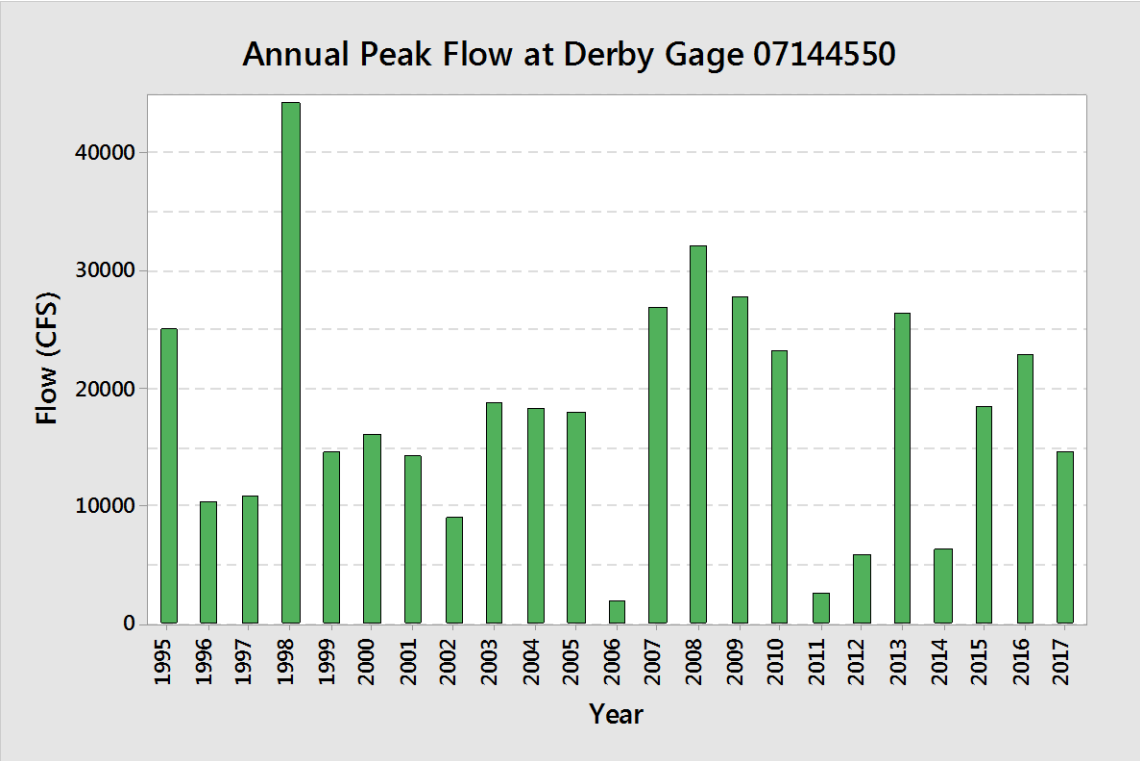


Figure 7. Monthly mean and median flows for U.S. Geological Survey gage 07144300 at Wichita located near Wichita (SC729) in the Arkansas River.

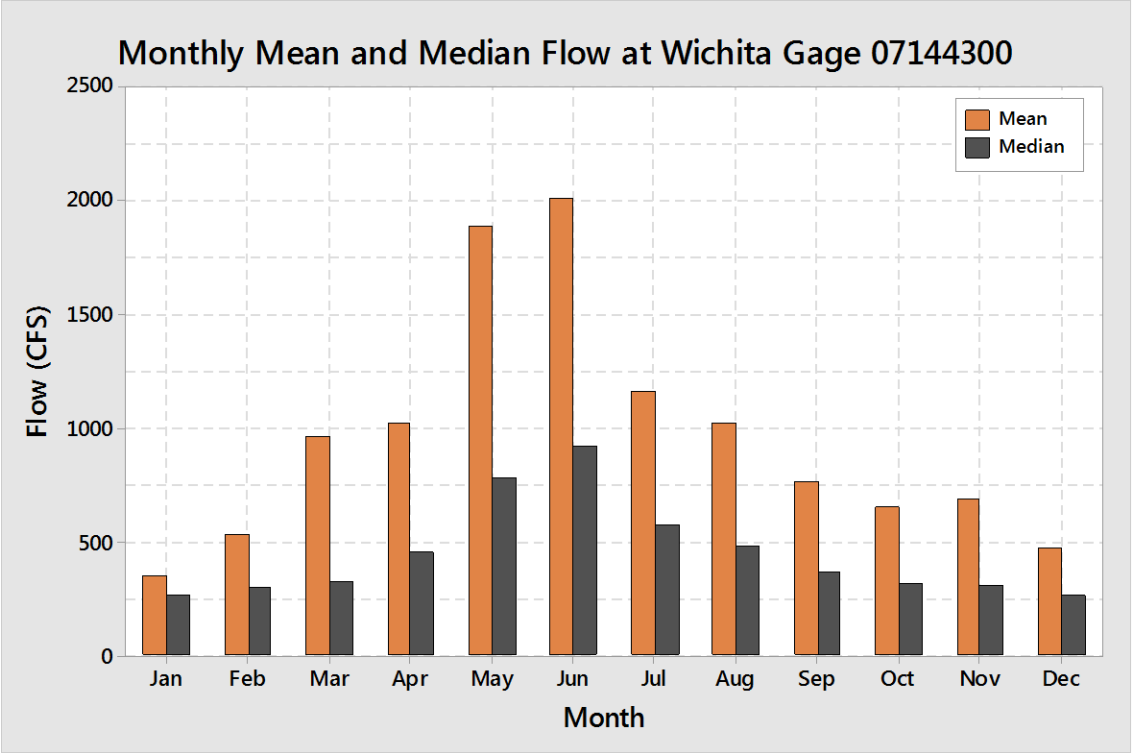


Figure 8. Monthly mean and median flows for U.S. Geological Survey gage 07144550 at Derby located at Derby (SC281) in the Arkansas River.

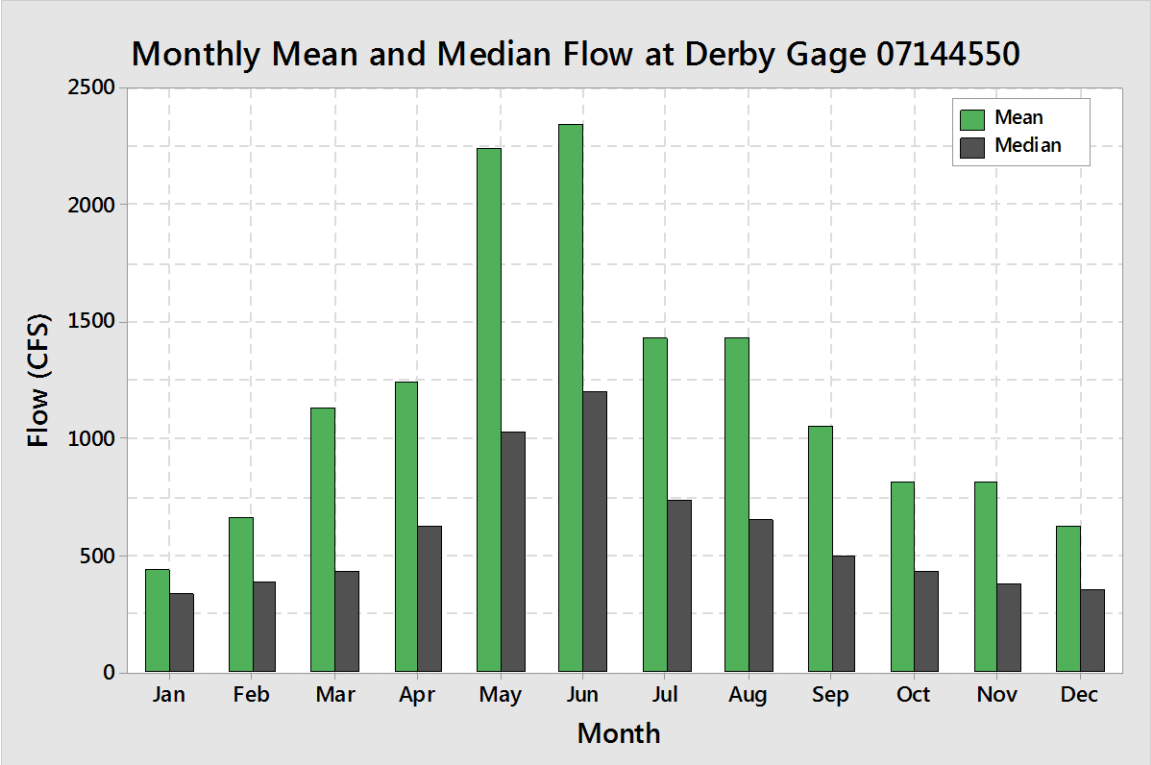
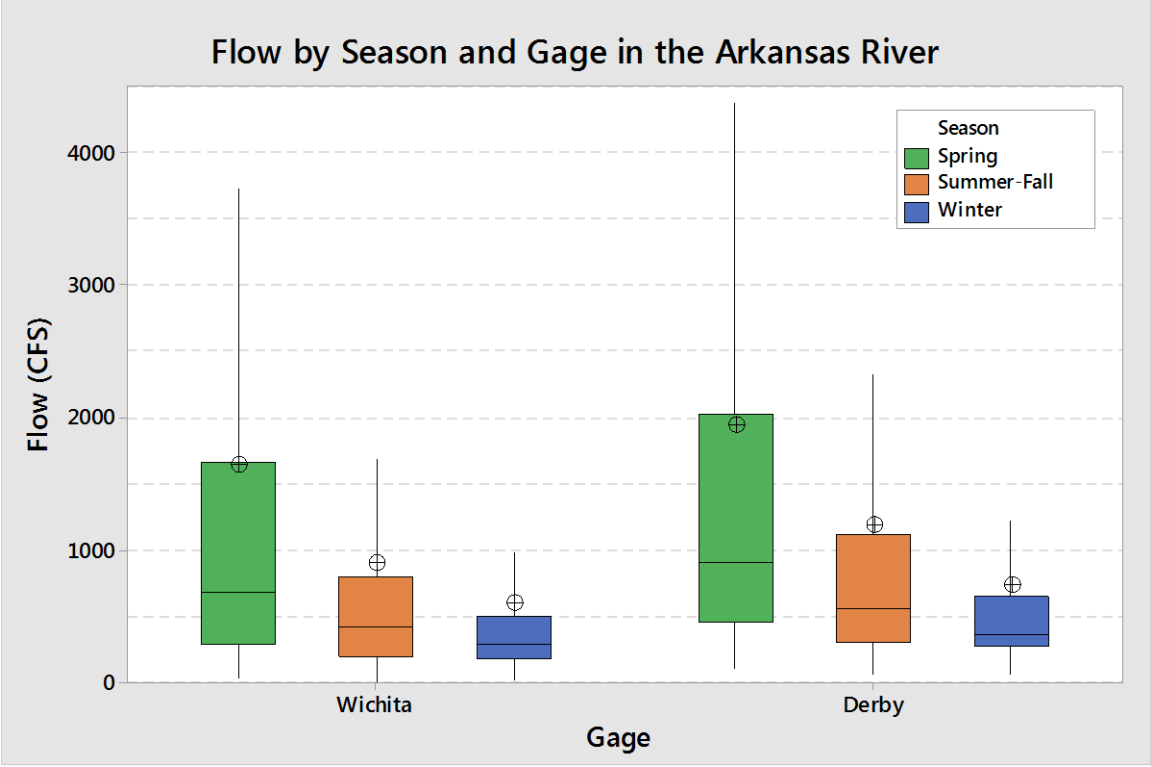
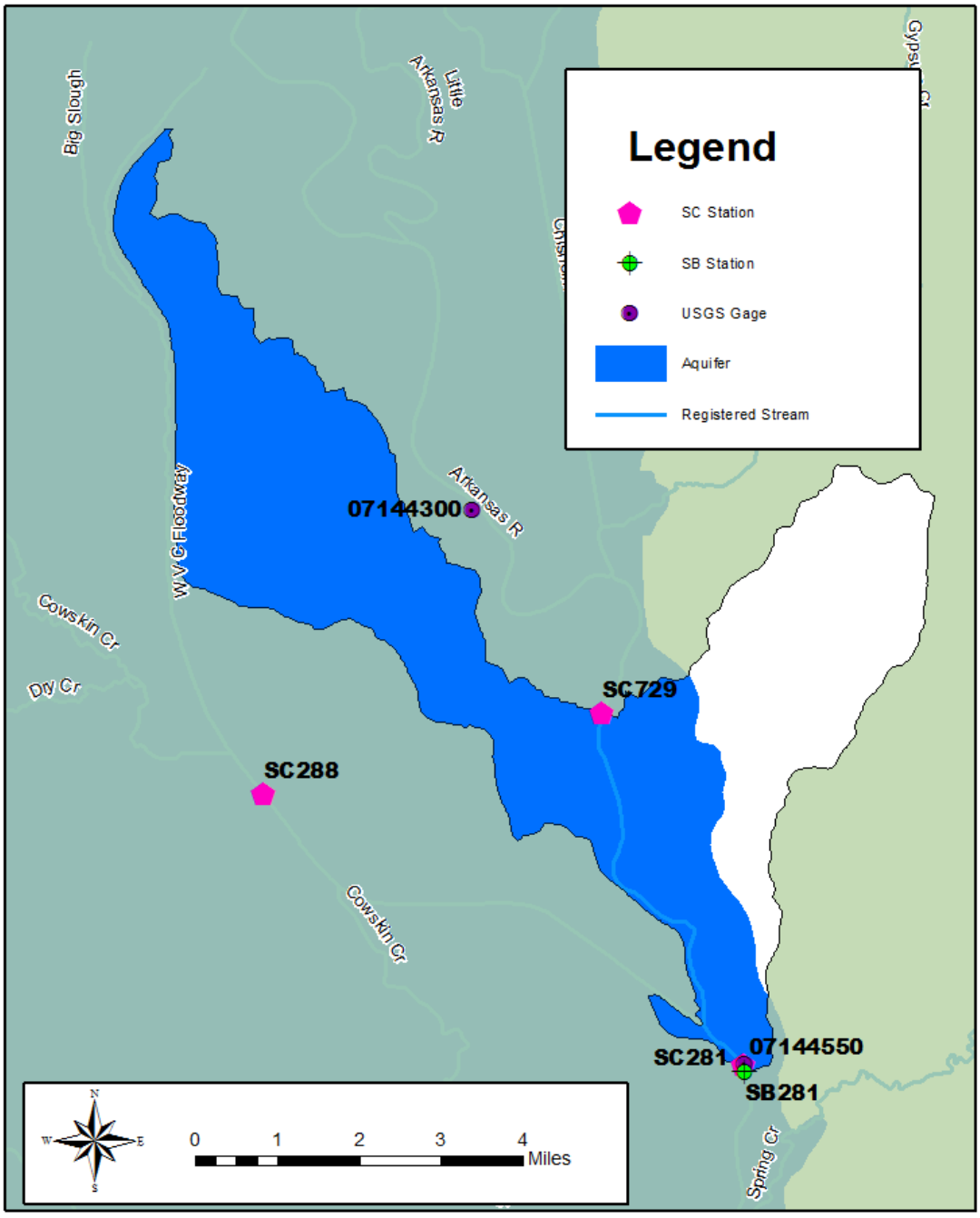


Figure 9. Flows by season for U.S. Geological Survey gaged sites located in the Arkansas River.



An additional hydrologic factor in this region is the presence of the alluvial High Plains Aquifer. The High Plains Aquifer is characterized by sandier soils with a thin vadose zone (Kansas Geological Survey, 2001). The majority of the watershed upstream of Derby (SC281) overlies a portion of this aquifer, which is designated as a sensitive groundwater recharge area (**Figure 10**; Kansas Geological Survey, 2013). Aquifer groundwater is used for high density irrigation and industrial and drinking water purposes, which can alter and impact hydrologic interactions between surface water and groundwater.

Figure 10. Map of sensitive groundwater areas in the Derby (SC281) Watershed (Kansas Geological Survey, 2013).



Nitrate Concentrations:

Throughout the period of record, nitrate concentrations at upstream Wichita (SC729) and tributary WVC Floodway (SC288) are substantially less than nitrate concentrations downstream at Derby (SC281; **Figure 11**). Concentrations at Wichita (SC729) and WVC Floodway (SC288) have never exceeded the water quality criterion, and neither of these stations are impaired for nitrate. As such, Wichita (SC729) and WVC Floodway (SC288) are not sources contributing to the nitrate impairment in the Derby (SC281) Watershed. In this TMDL, Wichita (SC729) is discussed at greater length solely for comparison purposes, while WVC Floodway (SC288) is considered here merely as a potential source of nitrate. Meanwhile, concentrations exceeding the numeric water quality criterion of 10 mg/L occurred three times at Derby (SC281) throughout the period of record, occurring once in 2011 and twice in 2012 (**Table 4**).

Figure 11. Nitrate concentrations at upstream Wichita (SC729) in the Arkansas River, tributary WVC Floodway in Cowskin Creek (SC288), and downstream Derby (SC281) in the Arkansas River.

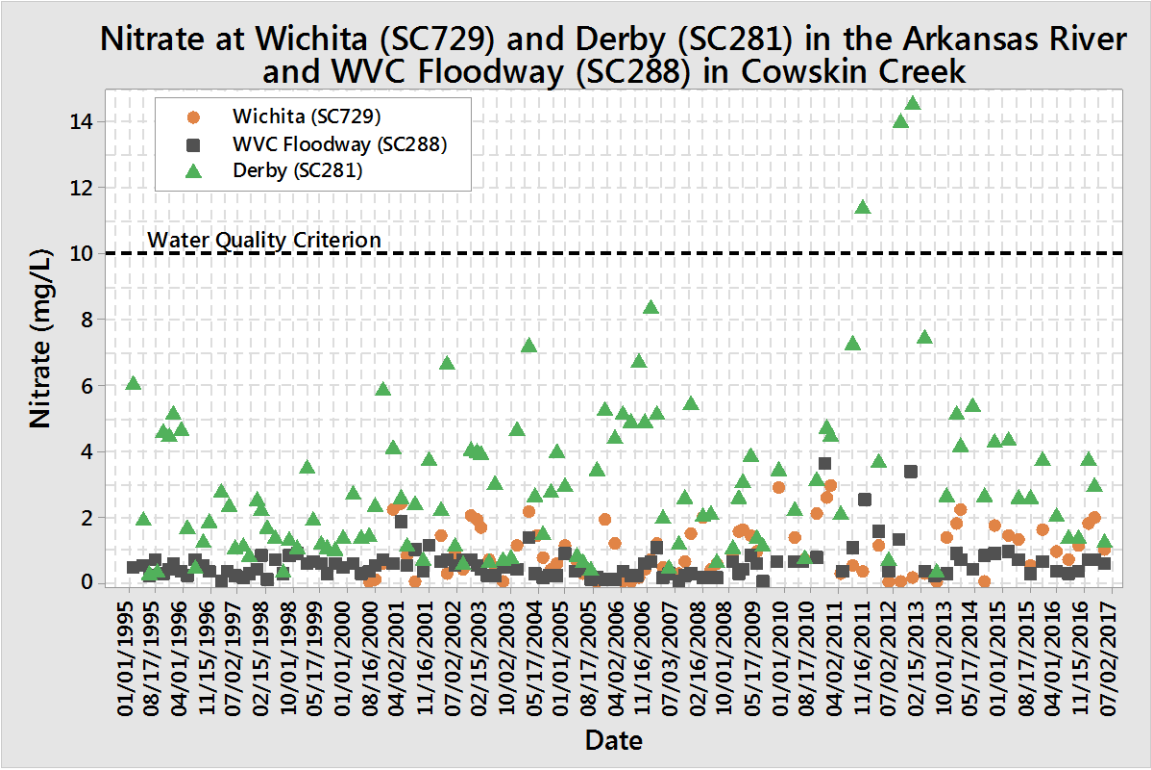


Table 4. Annual nitrate mean, median, and number of sampled excursions (nitrate concentrations greater than 10 mg/L) at Wichita (SC729) and Derby (SC281) in the Arkansas River. Values with no data are denoted with a – symbol.

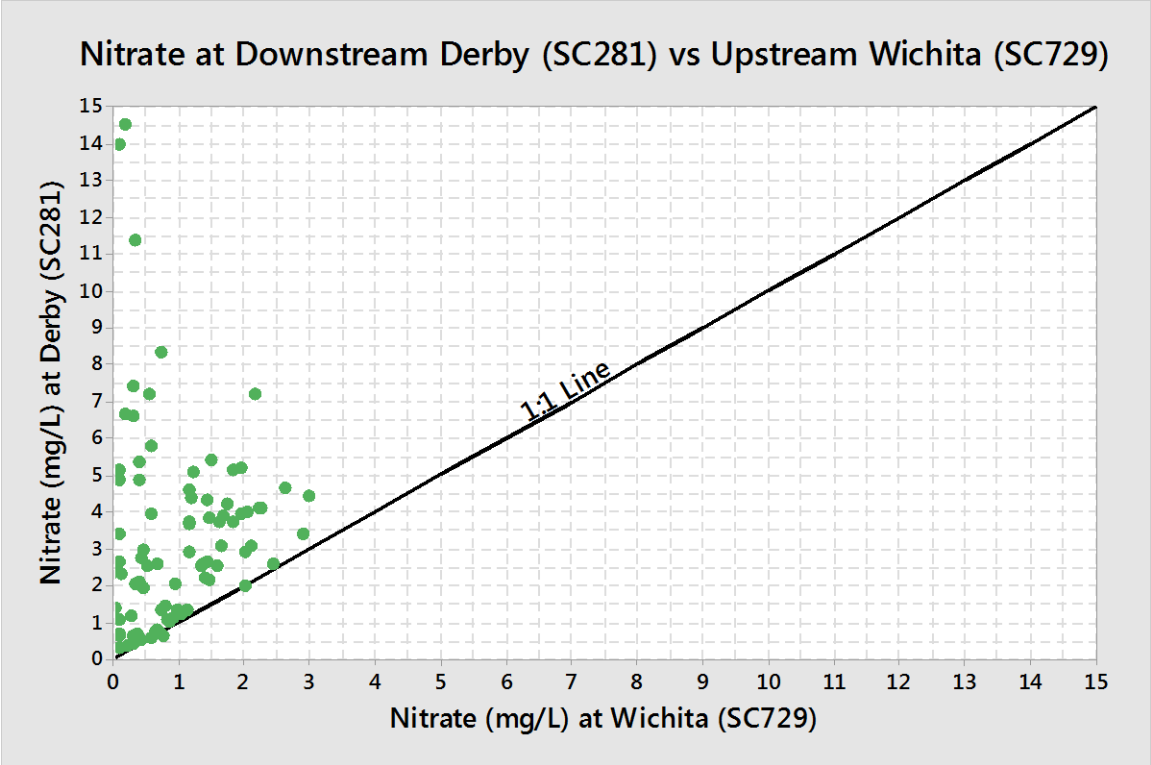
Year	Nitrate (mg/L)					
	Wichita (SC729)			Derby (SC281)		
	Mean	Median	Excursion	Mean	Median	Excursion
1995	–	–	0	2.9	3.1	0
1996	–	–	0	2.4	1.7	0
1997	–	–	0	1.7	1.7	0
1998	–	–	0	1.3	1.3	0
1999	–	–	0	1.6	1.2	0
2000	0.2	0.1	0	2.7	2.3	0
2001	1.1	1.0	0	2.4	2.4	0
2002	1.2	1.2	0	3.0	3.0	0
2003	0.8	0.7	0	2.2	1.8	0
2004	1.1	1.0	0	3.4	2.8	0
2005	0.6	0.3	0	2.0	0.8	0
2006	0.4	0.3	0	5.7	5.0	0
2007	0.7	0.5	0	2.7	2.2	0
2008	1.1	0.8	0	1.6	2.0	0
2009	1.4	1.4	0	2.5	3.0	0
2010	1.7	1.7	0	2.6	2.6	0
2011	1.0	0.4	0	6.2	5.8	1
2012	0.4	0.1	0	8.2	8.8	2
2013	0.9	0.8	0	3.8	3.8	0
2014	1.1	1.0	0	4.1	4.2	0
2015	1.2	1.4	0	3.3	3.1	0
2016	1.1	1.0	0	2.1	1.7	0
2017	1.5	1.5	0	2.1	2.1	0

Nitrate concentration summaries by season and percent flow exceedance conditions are presented in **Table 5**. Overall, downstream nitrate concentration means and medians are more than three times upstream concentrations: downstream Derby (SC281) has a nitrate concentration mean of 3.0 mg/L and median of 2.5 mg/L; upstream Wichita (SC729) has a nitrate concentration mean of 0.9 mg/L and median of 0.7 mg/L. Additionally, the overall nitrate concentrations range at Derby (SC281) is 0.2 to 14.5 mg/L, while concentrations at Wichita (SC729) range from 0.0 to 3.0 mg/L. Indeed, samples collected on concurrent days indicate that upstream nitrate concentrations of less than 1 mg/L can correspond to elevated downstream nitrate concentrations ranging from 2 to 14.5 mg/L (**Figure 12**).

Table 5. Nitrate concentration mean, median, minimum, maximum, and number of samples (N) by season (spring: April through June, summer-fall: July through October, winter: November through March) and flow range at Wichita (SC729) and Derby (SC281) in the Arkansas River. Values with no data are denoted with a – symbol.

Flow Range (%)	Wichita (SC729) Nitrate (mg/L)					Derby (SC281) Nitrate (mg/L)				
	Mean	Median	Minimum	Maximum	N	Mean	Median	Minimum	Maximum	N
Spring										
0-10	0.6	0.6	0.3	1.0	6	0.7	0.6	0.2	1.3	8
11-25	0.9	0.8	0.8	1.0	3	1.2	1.2	1.0	1.4	6
26-75	0.6	0.4	0.0	1.4	8	2.1	2.1	0.3	4.8	12
76-90	0.3	0.3	0.3	0.4	2	4.4	5.2	0.6	6.6	4
91-100	0.1	0.1	0.1	0.1	3	–	–	–	–	0
0-100	**0.5**	**0.4**	**0.0**	**1.4**	**22**	**1.9**	**1.3**	**0.2**	**6.6**	**30**
Summer-Fall										
0-10	0.8	0.8	0.8	0.8	1	0.6	0.6	0.3	1.0	2
11-25	0.5	0.4	0.1	1.1	6	0.9	1.0	0.4	1.3	9
26-75	0.8	0.5	0.0	2.1	13	2.5	2.5	0.3	6.6	22
76-90	0.4	0.5	0.1	0.6	3	5.8	5.8	5.8	5.8	1
91-100	0.3	0.3	0.1	0.5	5	9.3	9.3	4.9	14.0	4
0-100	**0.6**	**0.4**	**0.0**	**2.1**	**28**	**2.8**	**2.3**	**0.3**	**14.0**	**38**
Winter										
0-10	2.2	2.2	2.0	2.4	2	1.8	2.0	1.0	2.5	3
11-25	1.8	1.8	0.7	2.9	2	1.7	1.8	0.6	3.4	6
26-75	1.6	1.6	0.4	3.0	20	3.3	3.0	1.3	7.2	23
76-90	1.5	1.3	1.1	2.6	8	4.3	4.4	2.9	5.2	12
91-100	0.4	0.3	0.2	0.7	3	8.2	7.4	4.6	14.5	5
0-100	**1.5**	**1.5**	**0.2**	**3.0**	**35**	**3.8**	**3.7**	**0.6**	**14.5**	**49**
All Seasons										
0-10	1.0	0.8	0.3	2.4	9	1.0	1.0	0.2	2.5	13
11-25	0.8	0.7	0.1	2.9	11	1.2	1.1	0.4	3.4	21
26-75	1.1	1.3	0.0	3.0	41	2.7	2.6	0.3	7.2	57
76-90	1.1	1.1	0.1	2.6	13	4.4	4.6	0.6	6.6	17
91-100	0.2	0.2	0.1	0.7	11	8.7	7.4	4.6	14.5	9
0-100	**0.9**	**0.7**	**0.0**	**3.0**	**85**	**3.0**	**2.5**	**0.2**	**14.5**	**117**

Figure 12. Nitrate at downstream Derby (SC281) versus upstream Wichita (SC729) for concurrent day samples in the Arkansas River, June 20, 2000 to April 24, 2017.



Across the flow ranges and seasons, the upstream Wichita (SC729) has higher nitrate concentrations in winter, with the highest recorded concentration of 3 mg/L occurring during winter normal (26-75%) flow conditions (**Table 5**; **Figure 13**). In comparison, the downstream Derby (SC281) nitrate concentrations typically remain less than 3 mg/L during above normal (0-25%) flow conditions (**Figure 14**). During normal and below normal (76-100%) flow conditions, nitrate concentrations at Derby (SC281) increase, with concentrations exceeding the numeric water quality criterion of 10 mg/L only during the lowest flow conditions (91-100%) in summer-fall and winter. This trend at Derby (SC281) indicates that nitrate concentrations in this section of the Arkansas River are dominated by point sources during below normal flow, rather than nonpoint sources during above normal flow.

Figure 13. Nitrate by percent flow exceedance at Wichita (SC729) in the Arkansas River.

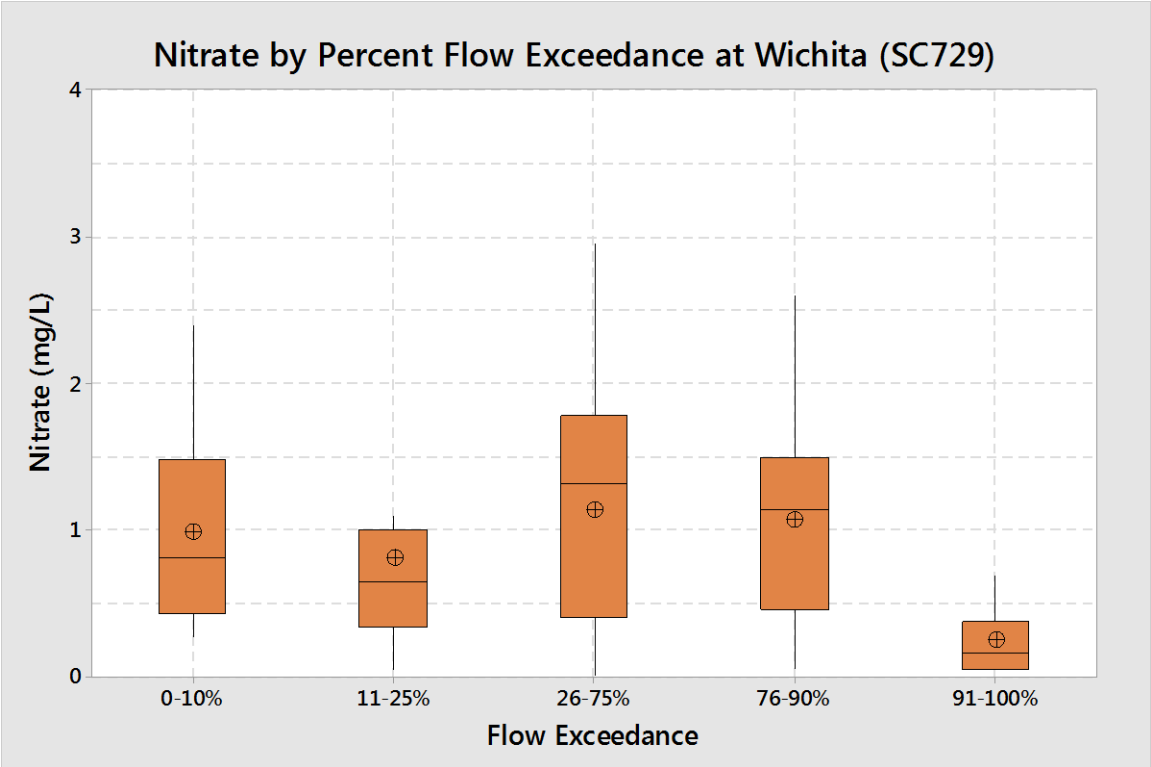
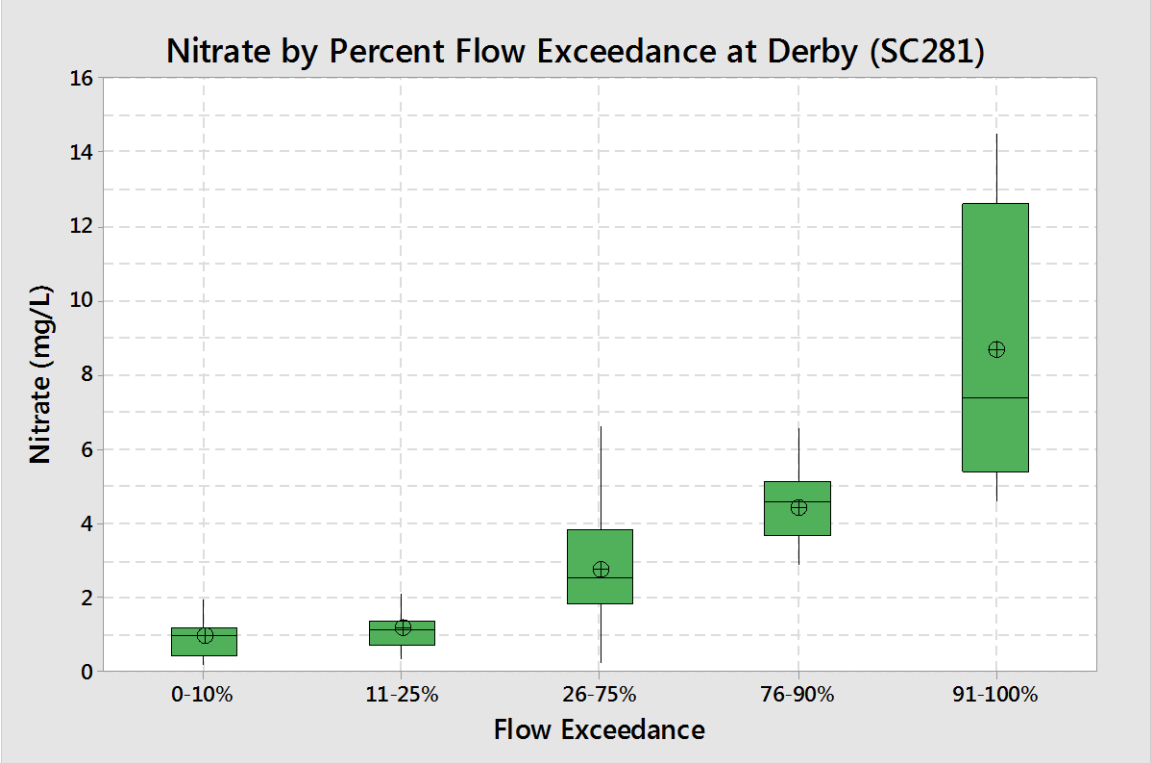


Figure 14. Nitrate by percent flow exceedance at Derby (SC281) in the Arkansas River.



Consistent with the previously noted trends, nitrate concentrations generally decline during all seasons as flows decline at Wichita (SC729; **Table 5**; **Figure 15**). Conversely, nitrate concentrations at Derby (SC281) increase during all seasons as flows decline (**Figure 16**). At both sites, winter nitrate concentrations tend to occur more frequently when flow exceedance is greater than 60%, while spring nitrate concentrations tend to occur more frequently when flow exceedance is less than 30%. This pattern corresponds to lower flows in the drier winter season and higher flows in the wetter spring season.

Figure 15. Nitrate by flow exceedance and season at Wichita (SC729) in the Arkansas River.

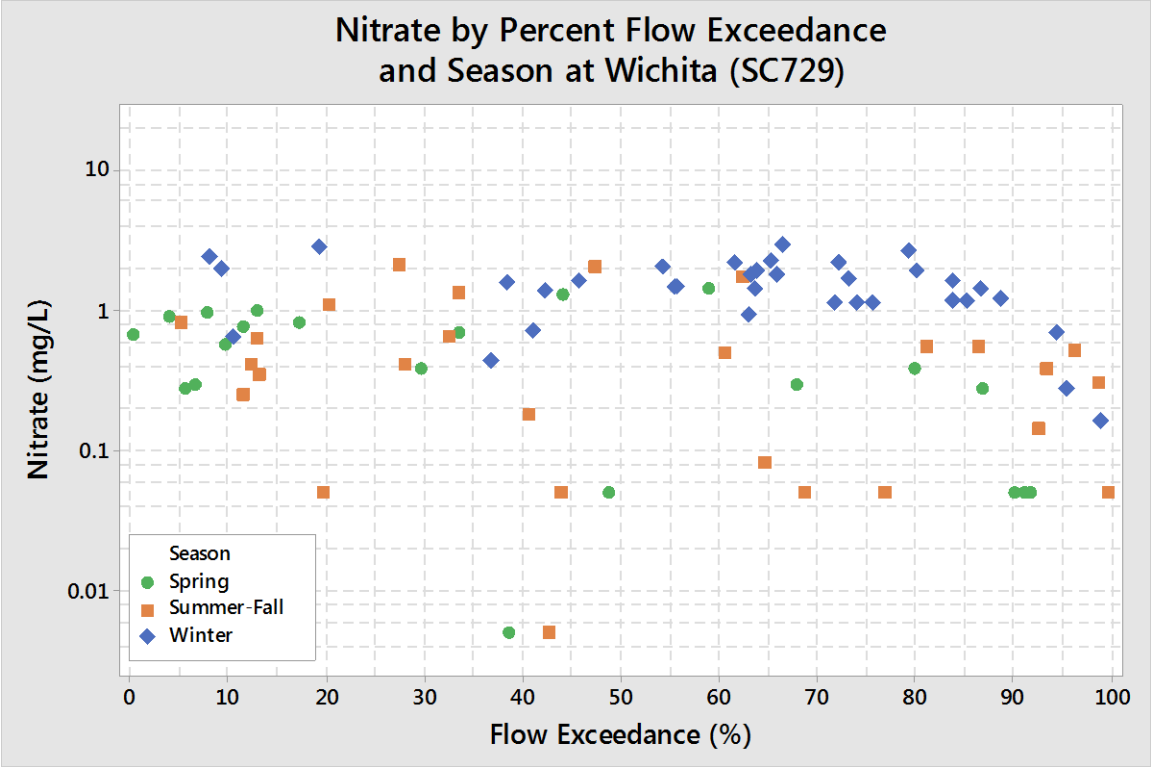
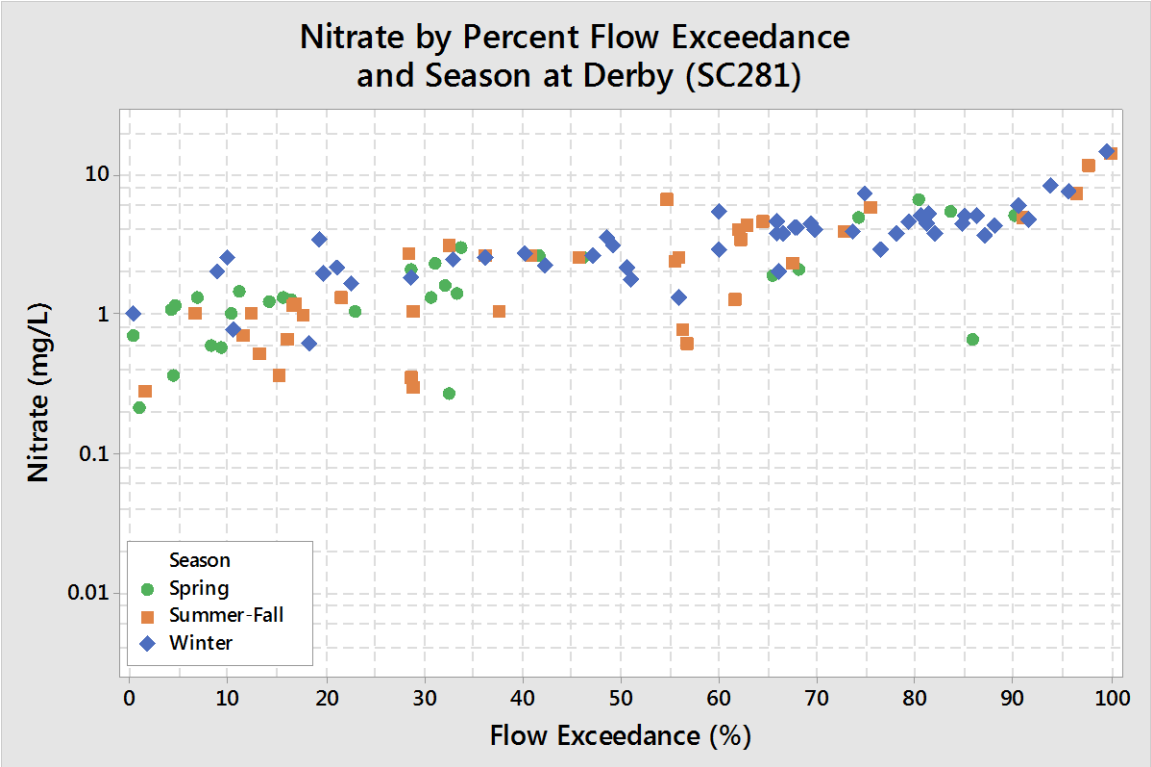


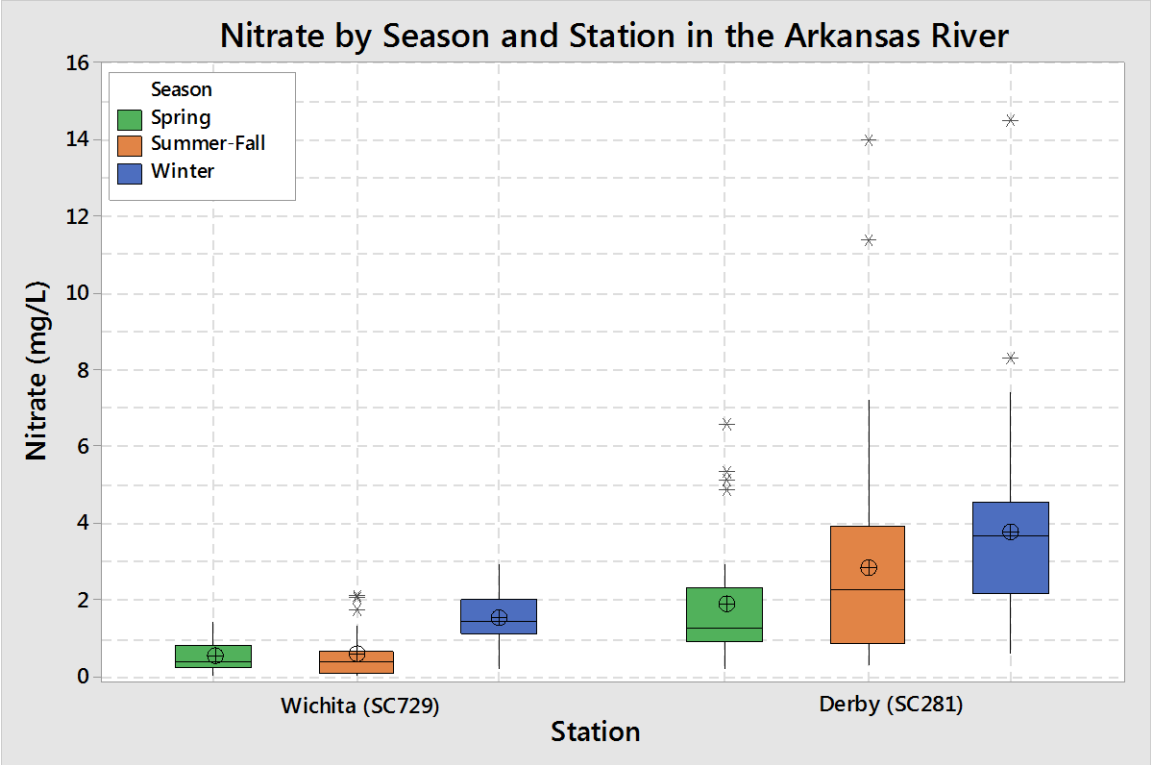
Figure 16. Nitrate by flow exceedance and season at Derby (SC281) in the Arkansas River.



Across the seasons, there is an increasing trend in nitrate mean and median concentrations from spring to winter at Derby (SC281; **Figure 17**). The overall spring mean concentration is 1.9 mg/L, while the overall winter mean concentration is 3.8 mg/L (**Table 5**). Likewise, the overall spring median concentration is 1.3 mg/L, while the overall winter median concentration is 3.7 mg/L. Nitrate concentrations exceeded the 10 mg/L numeric water quality criterion twice in summer-fall (July through October) and once in winter.

In contrast, upstream Wichita (SC729) has lower overall nitrate concentrations across all seasons. Nitrate mean and median concentrations are consistently low in spring and summer-fall, with mean concentrations of 0.5 and 0.6 mg/L, respectively, and median concentrations of 0.4 mg/L during both seasons; meanwhile, nitrate mean and median concentrations both increase to 1.5 mg/L in winter. This trend likely is a result of dilution from precipitation and runoff in spring, increased biological nitrate uptake in summer-fall, and reduced precipitation and biological nitrate uptake in winter low flow conditions.

Figure 17. Nitrate by season and station at Wichita (SC729) and Derby (SC281) in the Arkansas River.



Biological data regarding macroinvertebrate organisms and community are collected at KDHE stream biology (SB) stations. The sampled SB station in the watershed is SB281, Arkansas River near Derby. The SB station has been assessed using the Aquatic Life Use Support (ALUS) Index as described in Kansas' 2016 303(d) Methodology. The ALUS Index score consists of five categorizations of biotic conditions:

1. Macroinvertebrate Biotic Index (MBI): A statistical measure that evaluates the effects of nutrients and oxygen demanding substances on maroinvertebrates based on the relative abundance of certain indicator taxa (orders and families).
2. Kansas Biotic Index for Nutrients (KBI-N): A statistical measure mathematically equivalent to the MBI; however, the tolerance values are species specific and restricted to aquatic insect orders.
3. Ephemeroptera, Plecoptera, and Trichoptera (EPT): Abundance as a percentage of the total abundance of maroinvertebrates.
4. EPT Percent of Count (EPT % CNT): The percentage of organisms in a sample consisting of individuals belonging to the EPT orders.
5. Shannon's Evenness (SHN EVN): A measure of diversity that describes how evenly distributed the numbers of individuals are among the taxa in a sample.

These metrics are used to establish a score (**Table 6**) which is then translated into an indication of the biotic condition and life support category available in the stream (**Table 7**).

Table 6. Aquatic Life Use Support Index metrics with scoring ranges and standardized scores (Kansas Department of Health and Environment, 2016).

MBI	KBI-N	EPT	EPT% CNT	SHN EVN	Score
≤ 4.18	≤ 2.52	≥ 16	≥ 65	≥ 0.849	4
4.19-4.38	2.53-2.64	14-15	56-64	0.826-0.848	3
4.39-4.57	2.65-2.75	12-13	48-55	0.802-0.825	2
4.58-4.88	2.76-2.87	10-11	38-47	0.767-0.801	1
≥ 4.89	≥ 2.88	≤ 9	≤ 37	≤ 0.766	0

Table 7. Aquatic Life Use Support (ALUS) Index score range, interpretation of biotic condition, and support categories (Kansas Department of Health and Environment, 2016).

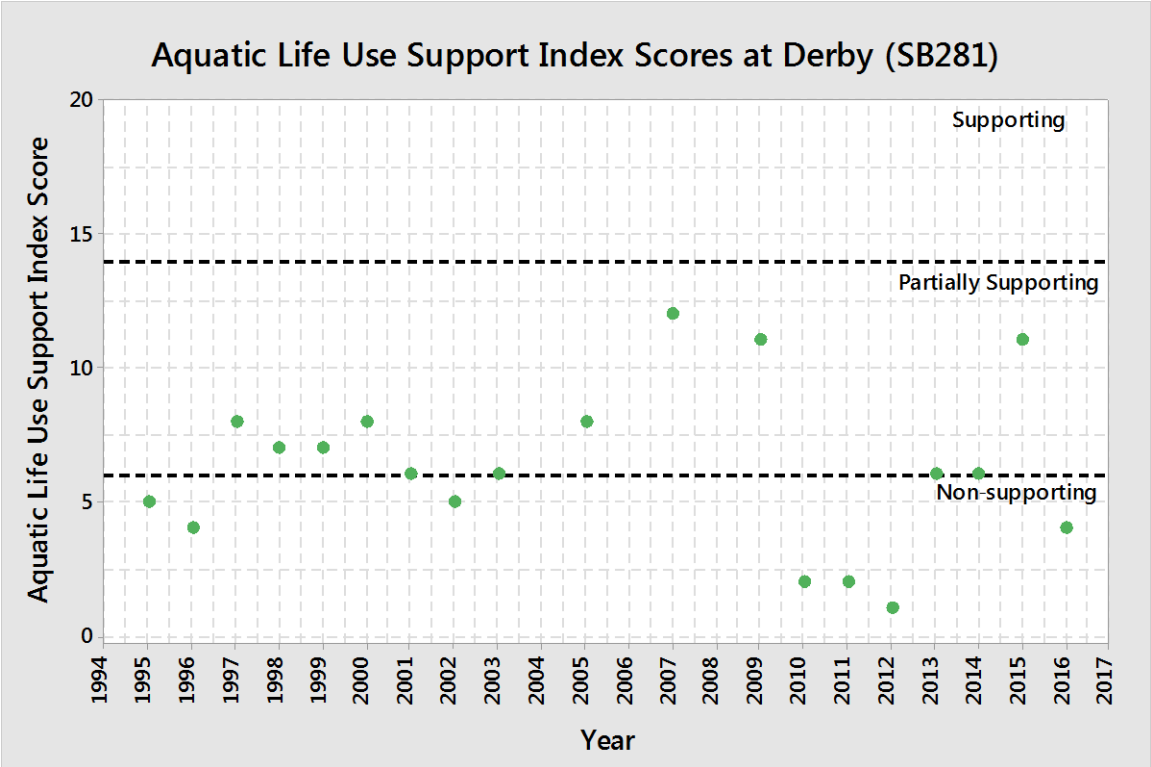
ALUS Index Score	Biotic Condition	Support Category
16-20	Very Good	Supporting
13-16	Good	
7-13	Fair	Partially Supporting
4-6	Poor	Non-supporting
1-3	Very Poor	

Biotic conditions were sampled annually at Derby (SB281) from 1995 to 2016 (except for 2004, 2006, and 2008). The station has a total of 19 samples with a mean ALUS Index score of 6, indicating biotic conditions are poor (**Table 8**). This station is classified as non-supporting for aquatic life and has never achieved the supporting category throughout the sampled period of record (**Figure 18**).

Table 8. Mean Aquatic Life Use Support (ALUS) Index score in the Arkansas River at Derby (SB281).

Station	Period of Record	Number of Samples	Mean ALUS Index Score	Biotic Condition	ALUS Index Support Category
Derby (SB281)	Oct. 3, 1995 to Oct. 20, 2016	19	6	Poor	Non-Supporting

Figure 18. Aquatic Life Use Support Index scores in the Arkansas River at Derby (SB281).



Desired Endpoint:

The ultimate endpoint of this TMDL will be to achieve the Kansas Water Quality Standards by reducing nitrate levels to attain full support of special aquatic life, domestic water supply and recreational uses in the river. The numeric endpoint for this TMDL is 10 mg/L nitrate as nitrogen. The 10 mg/L nitrate as nitrogen criterion is specific to the domestic water supply use (Kansas Surface Water Quality Standards: Tables of Numeric Criteria, 2017); however, it will also serve to protect the contact recreation and special aquatic life uses (U. S. Environmental Protection Agency, 2010). Nitrate concentrations at Derby (SC281) must not measure greater than 10 mg/L more than once in the most recent 10-year period of record to be considered for delisting. Achievement of this endpoint indicates nitrate loads are within the loading capacity of the stream, water quality standards are attained, and full support of the designated uses of the stream are restored.

3. SOURCE INVENTORY AND ASSESSMENT

Point Sources:

There are a total of eight National Pollution Discharge Elimination System (NPDES) permitted facilities within the Derby (SC281) Watershed (**Figure 1**; **Table 9**). Of the eight permitted facilities, one is a non-discharging lagoon, one is a concrete operation, two are facilities utilizing groundwater for non-contact cooling water, three are facilities implementing groundwater remediation, and one is a municipal mechanical wastewater treatment plant (WWTP). Additionally, there are four Municipal Separate Storm Sewer System (MS4) permits within the watershed.

The non-discharging lagoon within the watershed is operated by The Mann Cave. This facility is prohibited from discharging and is considered a temporary treatment system until the facility connects to city services. The concrete operation, CMC – West Robbins Plant, is a ready-mix concrete operation and distribution terminal that generates wastewater from washing out concrete equipment. This facility uses settling pits for their wash water, and clear water is then reused for on-site dust suppression. Domestic waste is discharged to the city system or to an on-site septic tank. Both of these systems are not expected to contribute nitrate to the watershed and are therefore assigned a wasteload allocation (WLA) of zero under this TMDL.

The two facilities utilizing groundwater for non-contact cooling are Leading Technology Composites and Wescon Plastics, LLC; the former manufactures aircraft parts and the latter manufactures molded plastics. Wescon Plastics, LLC adds chemicals for iron reducing bacteria, phosphorus sequestration, and sodium hypochlorite prior to use. At both facilities, groundwater pumped on-site is used for cooling and then discharged to the storm sewer without further treatment. The three facilities implementing groundwater remediation are McConnell Air Force Base, Globe Engineering, Inc., and Air Capital Flight Line, LLC. McConnell Air Force Base and Air Capital Flight Line, LLC are remediating fuel-contaminated groundwater and Globe Engineering, Inc. is removing volatile organic compounds. All three facilities treat their groundwater discharge with an air stripper. Air Capital Flight Line, LLC is the only permit currently in the permit renewal process due to the sale of the company. The five discussed facilities discharge domestic waste to the city system and currently do not monitor for nitrate; however, due to increasing levels of nitrate in groundwater in this region (Townsend et al., 2001), all five facilities are assigned a nitrate WLA under this TMDL.

The City of Wichita WWTP (Lower Arkansas River Plant) is a municipal mechanical plant with a design flow of 54 million gallons per day (MGD). It currently operates at 32.6 MGD, making it the largest discharger in the watershed, with a weekly monitoring requirement for nitrate plus nitrite. Previously, this facility was required to monitor nitrate and nitrite on a monthly basis from 2003 to 2012. In 2013, monitoring requirements changed to weekly samples of nitrate plus nitrite. Despite the combination of nitrate plus nitrite in the current reporting requirements, the 2003 to 2012 monitoring data demonstrates that the majority of the discharge from this facility is comprised of nitrate: mean nitrite is 0.79 mg/L and mean nitrate is 25.2 mg/L for the period of record. From 2003 to 2017, the discharge from this facility has a mean nitrate plus nitrite concentration of 27.4 mg/L and a daily nitrate plus nitrite load of 7,462 pounds per day (lbs/day).

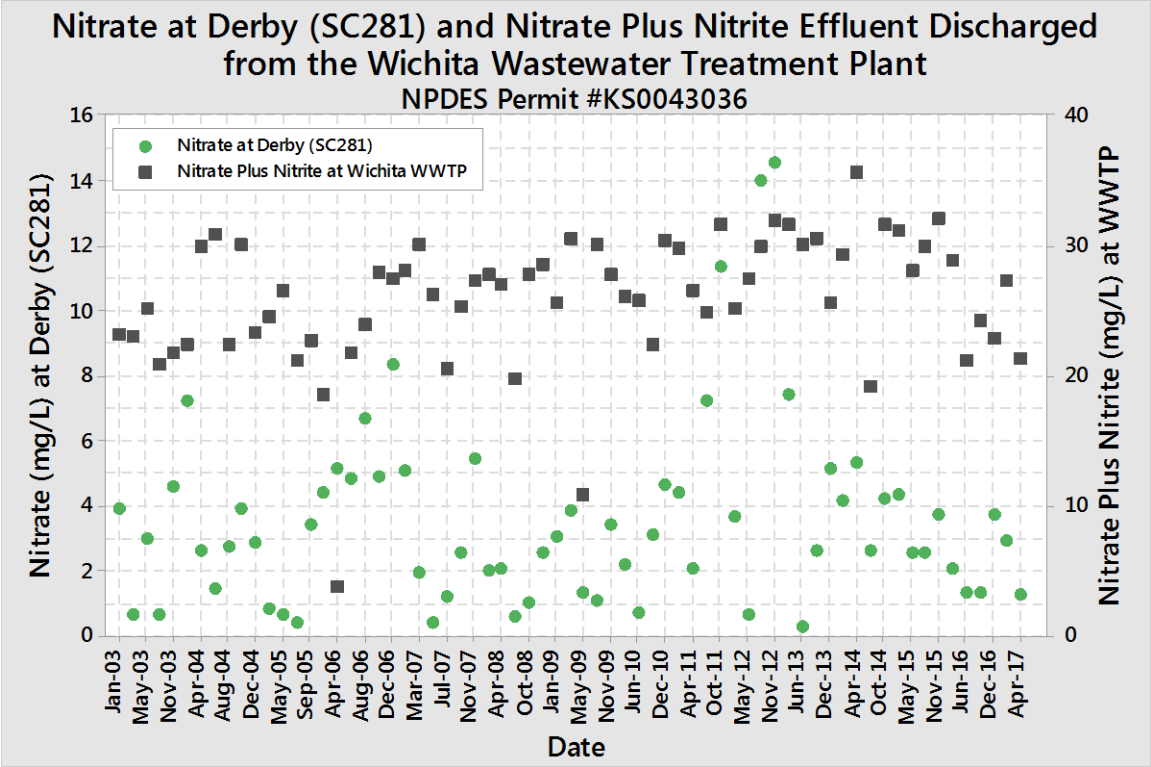
Table 9. National Pollution Discharge Elimination System (NPDES) facilities in the Derby (SC281) Watershed.

Permitee	KS Permit Number	NPDES Permit Number	Facility Type	Treatment Type	Receiving Stream	Permit Expiration	Current Flow (MGD)
City of Wichita - Lower Arkansas River Plant	M-AR94-IO01	KS0043036	Wastewater treatment plant	Municipal mechanical	Arkansas River	12/31/2017	32.6
Air Capital Flight Line, LLC	I-AR94-PO90	KS0098205	Industrial groundwater remediation	Air stripper	Arkansas River	12/31/2013*	0.086
Globe Engineering, Inc.	I-AR94-PO31	KS0086703	Industrial groundwater remediation	Air stripper	Arkansas River	09/30/2017	0.4
McConnell Air Force Base	F-AR94-PO25	KS0086452	Federal groundwater remediation	Air stripper	Arkansas River	04/30/2021	0.001
Leading Technology Composites	I-AR94-CO50	KS0089010	Industrial non-contact cooling - groundwater	N/A	Arkansas River	11/30/2017	0.02
Wescon Plastics, LLC	I-AR94-PO62	KS0000825	Industrial non-contact cooling - groundwater	N/A	Arkansas River	12/31/2017	0.36
CMC - West Robbins Plant	I-AR94-PR07	KSG110034	Concrete operation	Settling pit	Arkansas River	09/30/2017	0.0125
The Mann Cave	C-AR94-NO21	KSJ000165	Commercial lagoon system	Non-discharging lagoon	N/A	11/30/2018	0

Definitions: * - permit renewal in progress; N/A - not applicable

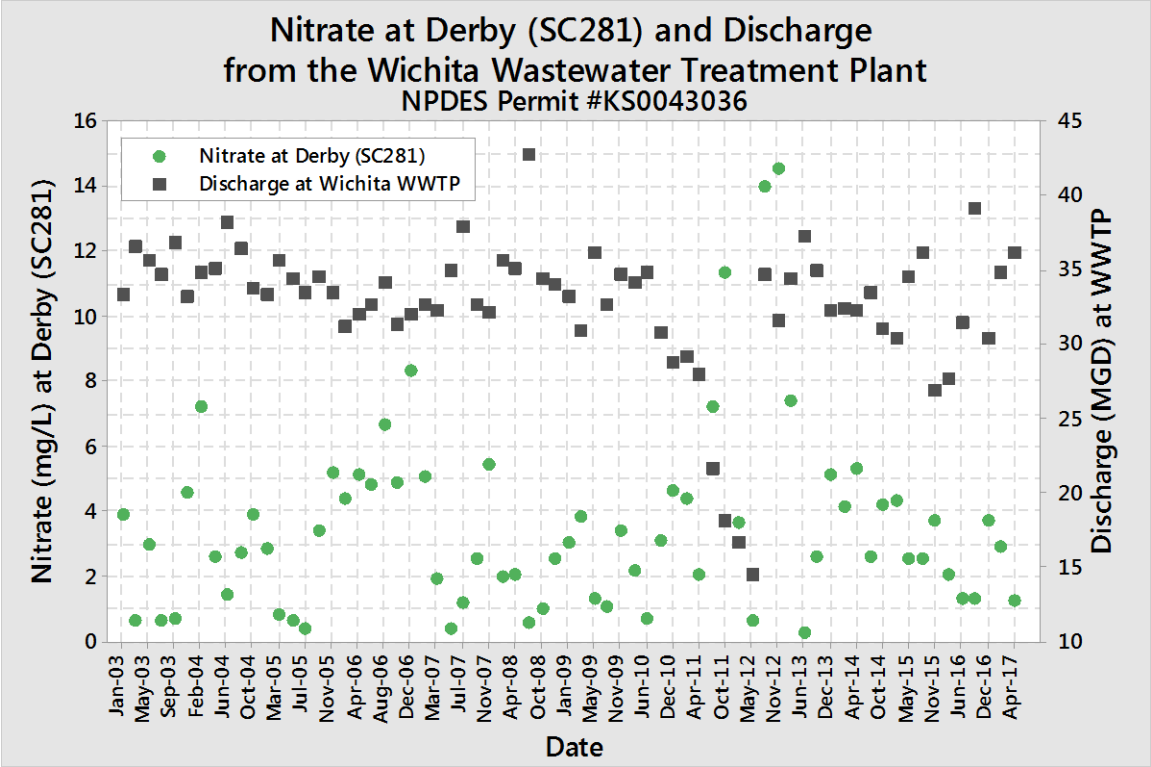
The analyses previously discussed in Section 2 indicated a dominant point source influence for nitrate in the Derby (SC281) Watershed. As discussed here in Section 3, the most significant point source of nitrate above this station is the City of Wichita WWTP (Lower Arkansas River Plant). The influence of the WWTP discharge in the Derby (SC281) Watershed was evaluated by comparing the monthly nitrate plus nitrite concentrations in the effluent of the City of Wichita WWTP (Lower Arkansas River Plant) to the monthly nitrate concentrations in the Arkansas River at Derby (SC281), where monthly concomitant data were available (**Figure 19**). Nitrate plus nitrite in effluent from the WWTP elevate nitrate concentrations in the watershed, creating a trend that generally corresponds to increased nitrate concentrations at Derby (SC281) with increased nitrate plus nitrite concentrations in WWTP discharge.

Figure 19. Nitrate plus nitrite effluent concentration from the City of Wichita Wastewater Treatment Plant (Lower Arkansas River Plant) contributed to the Arkansas River and nitrate concentration at Derby (SC281) in the Arkansas River, January 2003 to April 2017.



In addition to corresponding nitrate trends between the City of Wichita WWTP (Lower Arkansas River Plant) and Derby (SC281), the only nitrate excursions exceeding the 10 mg/L water quality criterion at Derby (SC281) occurred during operational malfunctions at the City of Wichita WWTP (Lower Arkansas River Plant). From June 2010 to June 2012, the WWTP reported discharges at nearly half the typical discharge volume due to an inadvertent and unauthorized diversion of effluent from a faulty gate valve (**Figure 20**). The three reported nitrate excursions occurred within 2011 and 2012, which corresponds to the increase in untreated effluent entering the Arkansas River from the WWTP. Since the WWTP returned to compliant operation, there have been no further nitrate excursions. Due to its clear impact upon the Derby (SC281) Watershed, the City of Wichita WWTP (Lower Arkansas River Plant) has been assigned a WLA under this TMDL.

Figure 20. Discharge from the City of Wichita Wastewater Treatment Plant (Lower Arkansas River Plant) contributed to the Arkansas River and nitrate concentrations at Derby (SC281) in the Arkansas River, January 2003 to April 2017.



The four MS4 permits within the Derby (SC281) Watershed authorize the Kansas Department of Transportation – Wichita and Sedgwick County, McConnell Air Force Base, Sedgwick County, and the City of Wichita to discharge stormwater (**Table 10**). Under these permits, the entities are expected to develop Stormwater Management Plans (SMPs) and implement Best Management Practices (BMPs) within their jurisdictions in order to reduce pollutant loading to waterbodies during rainfall events. Excessive nitrate concentrations from urban stormwater are associated with an increase in nitrate with increased streamflow; however, sites dominated by WWTP point sources will display a decrease in nitrate with increased streamflow, due to the effects of dilution (Graham et al., 2014). As discussed previously, Derby (SC281) exhibits patterns indicating a dominant WWTP point source for nitrate. As such, this TMDL does not establish a WLA for stormwater, but rather initially seeks to establish a WLA for more dominant point sources.

Table 10. National Pollution Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4s) permits in the Derby (SC281) Watershed.

Permitee	KS Permit Number	NPDES Permit Number	Permit Expiration
Kansas Department of Transportation	M-AR94-SU02	KSR410012	01/31/2019
McConnell Air Force Base	F-AR94-SU01	KSR410018	01/31/2019
Sedgwick County	M-AR94-SU01	KSR410032	01/31/2019
City of Wichita	M-AR94-SO01	KS0091049	07/31/2019

Livestock and Waste Management Systems:

There are no animal feeding operations or certified animal feeding operations certified, registered, or permitted within the Derby (SC281) Watershed. However, the Derby (SC281) Watershed is located within Sedgwick County, which has a total of 320 farms according to the 2012 U.S. Department of Agriculture Agricultural Census (**Table 11**). There has been a 33% decline in the number of farms and a 68% decline in the total cropland within Sedgwick County since 2007. Sheep and lambs are the dominant livestock within the county, with 3,034 units as of 2012, followed by poultry, with 2,330 units as of 2012 (**Table 12**). The sheep and lambs and poultry industries are also the only livestock industries growing within this county, with 106.3% and 5.2% increases in livestock, respectively.

Table 11. Agricultural census results for farms and cropland in Sedgwick County, 2007 and 2012 (U.S. Department of Agriculture, 2012).

Year	Total Farms	Total Cropland (acres)
2007	481	81,603
2012	320	25,979
Percent Change	-33	-68

Table 12. Agricultural census results for livestock in Sedgwick County, 2007 and 2012 (U.S. Department of Agriculture, 2012).

Livestock	Units, 2007	Units, 2012	Percent Change (%)
Sheep and lambs	1,471	3,034	106.3
Poultry	2,215	2,330	5.2
Hog and pigs	3,336	1,990	-40.3
Cattle on feed	4,218	131	-96.9

Land Use:

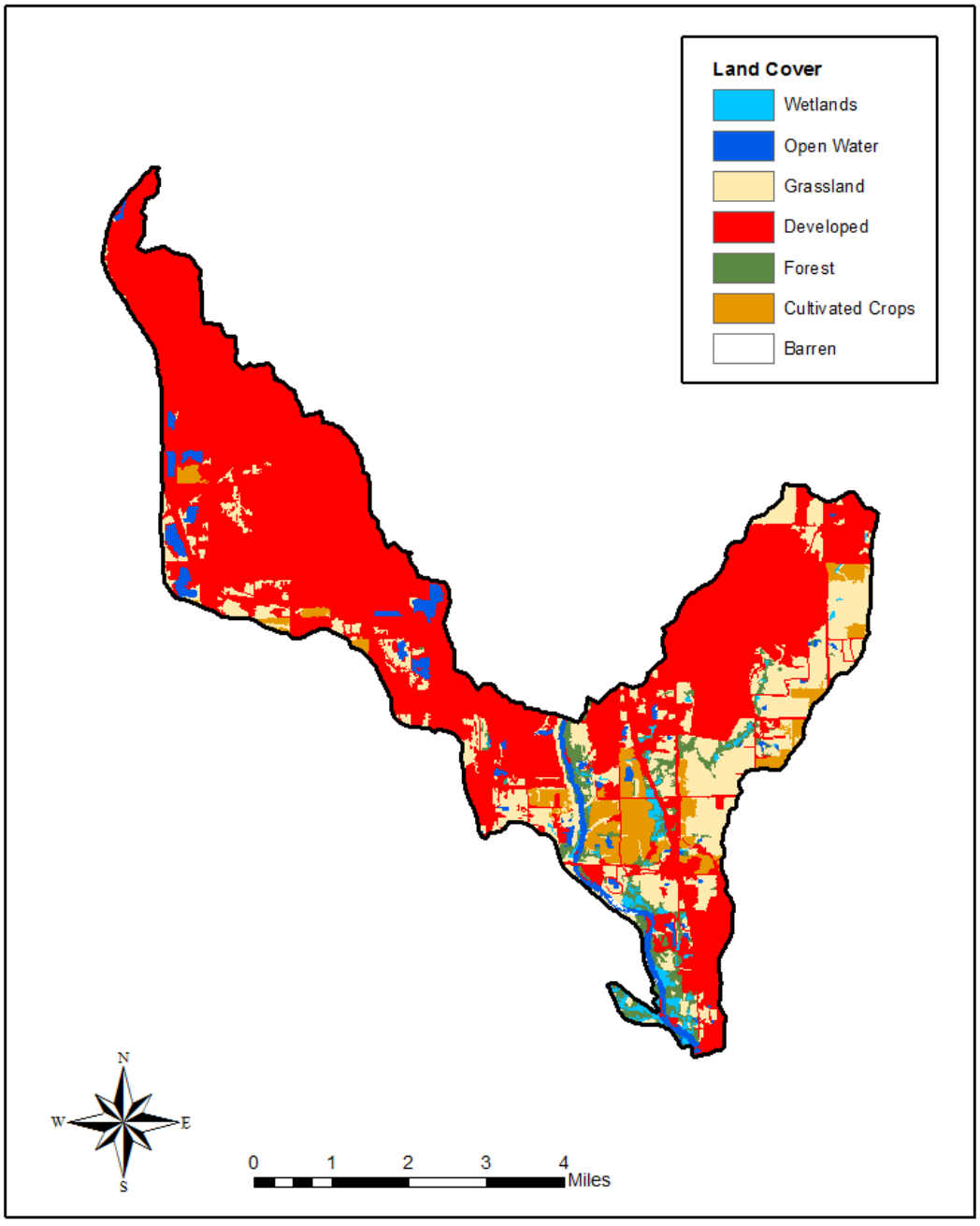
The majority of the Derby (SC281) Watershed is within the limits of the City of Wichita. The 2011 National Land Cover Database indicates the watershed is dominated by developed land, with 68% of the watershed developed (**Table 13**; **Figure 21**; Homer et al., 2015). Built infrastructure and impervious surfaces in urban environments increase runoff, which can

potentially contribute to nitrate loads in this watershed. The second most prevalent land use category in this watershed is grassland, which covers 18% of the watershed.

Table 13. Land cover by percent in the Derby (SC281) Watershed (Homer et al., 2015).

Land Cover	Wetlands	Open Water	Grassland	Forest	Developed	Cultivated Crops	Barren	Total
Percent (%)	1	4	18	4	68	5	0	100

Figure 21. Map of land cover in the Derby (SC281) Watershed (Homer et al., 2015).



Population Density:

The Derby (SC281) Watershed is located mainly within the city limits of Wichita and entirely within Sedgwick County. According to the 2010 U.S. Census Bureau, the City of Wichita has a population of approximately 382,000 and Sedgwick County has a population of approximately 498,000 (**Table 14**). Populations within the City of Wichita and Sedgwick County have increased 11% and 10%, respectively, from the 2000 to 2010 census; however, population density within the City of Wichita has declined by 5%, while population density within Sedgwick County has increased by 10%. This trend indicates an increase in urban sprawl and suburban development, which is corroborated by the decline in farms and cropland in the 2012 Agricultural Census (**Table 11**). Overall, the Kansas Water Office estimates that by 2040 the population of the City of Wichita will increase by approximately 55,000 and the population of Sedgwick County will increase by approximately 103,000.

Table 14. Census results in 2000 and 2010 for the City of Wichita and Sedgwick County (U.S. Census Bureau, 2010) and 2040 population projections (Kansas Water Office, 2002).

Location	Population, 2000	Population, 2010	Population Change (%)	Population Density, 2000 (population/mi^2)	Population Density, 2010 (population/mi^2)	Population Density Change (%)	Population Projection, 2040
City of Wichita	344,284	382,368	11	2,536	2,400	-5	436,922
Sedgwick County	452,869	498,365	10	453	500	10	601,724

On-Site Waste Systems:

Sedgwick County, which encompasses the Derby (SC281) Watershed, is comprised predominately of urbanized areas (92%) that are served by public sewer systems (**Table 15**; U.S. Census Bureau, 2010); however, the rural population (8%) may not be connected to the public sewers. According to the U.S. Environmental Protection Agency's Spreadsheet Tool for Estimating Pollutant Load (STEPL), there are a total of 10 septic systems located in this watershed. Septic systems in the state of Kansas typically have an estimated 10-15% failure rate (Electric Power Research Institute provided by U.S. Environmental Protection Agency, 2017). Failing on-site septic systems have the potential to contribute to nutrient loading in the watershed. However, because of the small number of them and their relatively small flows, failing on-site septic systems would not be considered a source of nitrate loading within the watershed and would not contribute to the nitrate impairment in the Arkansas River.

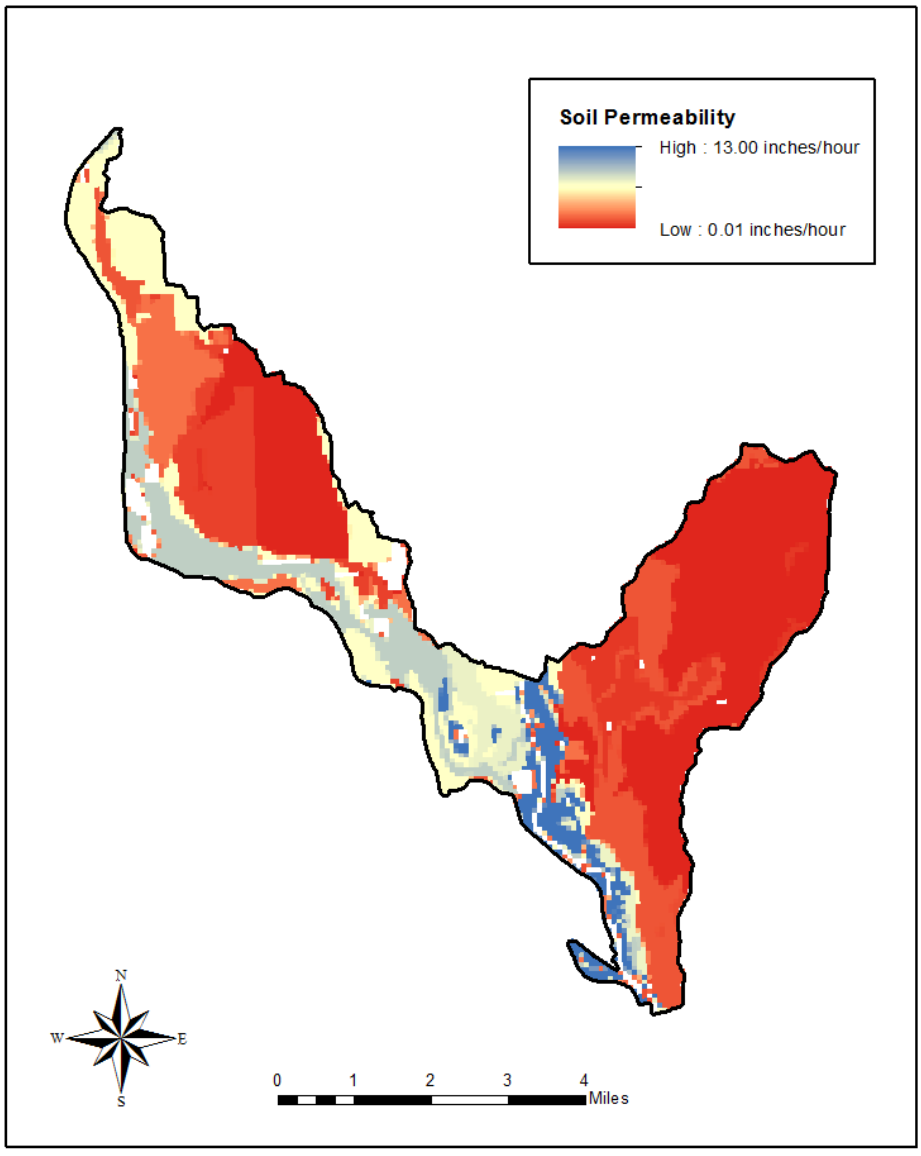
Table 15. Census results by urban and rural population for Sedgwick County (U.S. Census Bureau, 2010).

Sedgwick County	Population, 2010	Percent
Urban	460,197	92
Rural	38,168	8

Contributing Runoff:

Runoff conditions can occur as a result of either infiltration-excess (precipitation exceeds the infiltration rate of the soil) or saturation-excess (precipitation falls on soils saturated due to an elevated water table), causing overland flow (Juracek, 2000). Overland flow can impact the quality of water entering streams, thereby impacting water-quality loads. Soil permeability categories in Kansas have been defined by the following criteria in inches per hour (in/hr): very high (3.43 in/hr), high (2.86 in/hr), moderate (2.29 in/hr), low (1.71 in/hr), very low (1.14 in/hr), and extremely low (0.57 in/hr; Juracek, 2000). According to the Natural Resources Conservation Service (NRCS) State Soil Geographic Database (STATSGO), the Derby (SC281) Watershed has a soil permeability range of 0.01 to 13.00 in/hr (**Figure 22**). Within the watershed, 14% of the area has a soil permeability less than 2.86 in/hr. Overall, the watershed has a mean soil permeability of 3.22 in/hr, placing the overall watershed in the high soil permeability category.

Figure 22. Map of Natural Resources Conservation Service State Soil Geographic Database soil permeability in the Derby (SC281) Watershed.



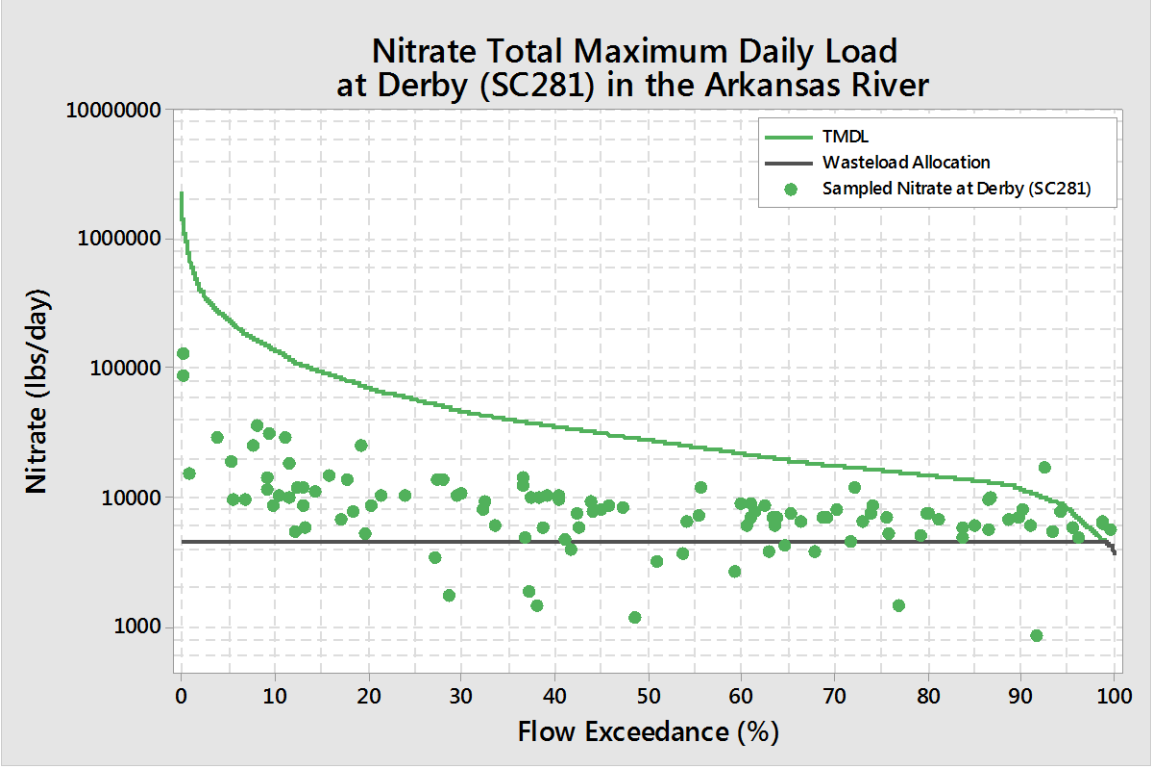
Background Levels:

Organic material, atmospheric deposition, and groundwater upwelling can contribute various forms of nitrogen to streams, which can create ambient levels of nitrate due to nitrification and denitrification. Background nitrate levels should result in minimal loading to the stream, making a violation of water quality standards through ambient nitrate levels unlikely.

4. ALLOCATION OF POLLUTANT REDUCTION RESPONSIBILITY

This TMDL, and the associated load capacity, is established to meet the existing nitrate water quality criterion of 10 mg/L at Derby (SC281) in the Arkansas River (**Figure 23**). The established TMDL emphasizes nitrate reductions from point sources, particularly the municipal WWTP, as they are the primary contributors of nitrate in this watershed. The total nitrate WLA for point sources in this TMDL watershed is 4,550.06 lbs/day. A load allocation (LA) is established to account for nonpoint sources of nitrate, as well. The LA is defined as the area bounded by the TMDL curve and the total WLA, and will be reassessed as needed to further reduce nitrate concentrations. Additionally, a percentage of the load capacity has been set aside as an allocation for a margin of safety, which is established at 10%, to protect against the uncertainty in nitrate loading (**Table 16**).

Figure 23. Nitrate Total Maximum Daily Load (TMDL) at Derby (SC281) in the Arkansas River.



For purposes of comparing current nitrate loading conditions in the river to the expected reduction in nitrate loading, the current condition was evaluated using the maximum nitrate concentration for each flow exceedance range. The highest nitrate concentration occurs at 90 percent flow exceedance, which is the only current load condition to exceed the load capacity of the stream. Sampled nitrate concentrations at Derby (SC281) were converted to loads for comparison with the TMDL (**Figure 23**). Congruent with the current load conditions, only nitrate samples from below normal flow conditions (90-100%) exceed the TMDL, further supporting the emphasis this TMDL places upon reducing municipal WWTP nitrate.

Table 16. Current load conditions (based upon the maximum nitrate concentration for each flow exceedance range), wasteload allocation, load allocation, reserve allocation, margin of safety, and total load capacity (TMDL) at Derby (SC281) in the Arkansas River.

Flow Exceedance (%)	Flow at Terminus (CFS)	Maximum Nitrate Concentration (mg/L)	Current Condition (lbs/day)	Wasteload Allocation (lbs/day)	Load Allocation (lbs/day)	Margin of Safety (lbs/day)	Load Capacity (lbs/day)
90	219	14.5	17,153	4,550	6,093	1,183	11,826
75	303	6.6	10,766	4,550	10,176	1,636	16,362
50	521	7.2	20,172	4,550	20,771	2,813	28,134
25	1,070	3.4	19,876	4,550	45,452	5,778	57,780
10	2,570	3.4	46,561	4,550	120,352	13,878	138,780

Point Sources:

The nitrate WLAs assigned to all permitted facilities are based upon current design flows for each facility, where available; in the case of some facilities using groundwater, no design flow is established, and the average daily discharge is used (**Table 17**). The Mann Cave and CMC – West Robbins Plant are both assigned a WLA of zero, as the former is a non-discharging lagoon and the latter is a concrete operation that is not expected to discharge nitrate.

This TMDL considers nitrate from industries using groundwater for cooling or remediation, as the shallow aquifer in this watershed has potentially elevated nitrate concentrations. Therefore, each facility is assigned a nitrate concentration of 5 mg/L to ensure against increased groundwater nitrate contributions to surface water. Accordingly, nitrate WLAs assigned to all facilities included in this category are: Leading Technology Composites (WLA: 0.84 lbs/day); Wescon Plastics, LLC (WLA: 15.04 lbs/day); McConnell Air Force Base (WLA: 0.04 lbs/day); Globe Engineering, Inc. (WLA: 19.46 lbs/day); and Air Capital Flight Line, LLC (WLA: 3.68 lbs/day).

Nitrate exceedances at Derby (SC281) occur only during below normal flow conditions that correspond to elevated nitrate concentrations in effluent and inappropriate operation of the municipal WWTP. Therefore, the WLA for the City of Wichita WWTP (Lower Arkansas River Plant) set forth in this TMDL is a concentration of 10 mg/L and a load of 4,511 lbs/day. To achieve the water quality criterion, the City of Wichita WWTP (Lower Arkansas River Plant) will be required to reduce nitrate concentrations by 17.4 mg/L and nitrate loads by 2,951 lbs/day.

Table 17. Nitrate wasteload allocations for permitted facilities in the Derby (SC281) Watershed.

Permitee	KS Permit Number	NPDES Permit Number	Facility Type	Design Flow (MGD)	Nitrate Wasteload Allocation Concentration (mg/L)	Nitrate Daily Wasteload Allocation (lbs/day)	Nitrate Annual Wasteload Allocation (lbs/year)
City of Wichita - Lower Arkansas River Plant	M-AR94-IO01	KS0043036	Wastewater treatment plant	54	10	4,511	1,646,515
Air Capital Flight Line, LLC	I-AR94-PO90	KS0098205	Groundwater remediation	0.088	5	3.68	1,342
Globe Engineering, Inc.	I-AR94-PO31	KS0086703	Groundwater remediation	0.466	5	19.46	7,104
McConnell Air Force Base	F-AR94-PO25	KS0086452	Groundwater remediation	0.001	5	0.04	15.25
Leading Technology Composites	I-AR94-CO50	KS0089010	Non-contact cooling - groundwater	0.02	5	0.84	305
Wescon Plastics, LLC	I-AR94-PO62	KS0000825	Non-contact cooling - groundwater	0.36	5	15.04	5,488
CMC - West Robbins Plant	I-AR94-PR07	KSG110034	Concrete operation	0.0125	0	0	0
The Mann Cave	C-AR94-NO21	KSJ000165	Non-discharging Lagoon	0	0	0	0
Nitrate Total Wasteload Allocation						4,550.06	1,660,769.3

Nitrate concentrations at above normal flow conditions are indicative of dilution, and all nitrate exceedances within this watershed occurred during below normal flow conditions. As such, current nitrate concentrations are indicative of point source loading, rather than nonpoint source stormwater runoff. Therefore, the four MS4 permits within the watershed are not presently assigned a nitrate WLA. This WLA will be reassessed once the previously discussed impairments have been addressed in order to further reduce nitrate loading in the watershed.

Nonpoint Sources:

The LA is established to account for nonpoint sources of nitrate in the watershed. Nitrate concentrations during above normal flow conditions currently do not exceed the water quality

criterion of 10 mg/L. Therefore, the LA is defined as the area bounded by the TMDL curve and the total WLA (**Figure 23**). Under these conditions, nonpoint sources of nitrate will not exceed the water quality criterion or the loading capacity of the Arkansas River. Once point source impairments have been addressed, this LA will be reassessed in order to reduce nonpoint source nitrate loading in the watershed.

Defined Margin of Safety:

The margin of safety provides protection against the uncertainty of nitrate loading to the Arkansas River and the endpoints of the TMDL. The margin of safety is explicitly set at 10% of the calculated nitrate load capacity (**Table 16**). This allocation compensates for the lack of knowledge regarding the relationship between the allocated loadings and the resulting water quality.

State Water Plan Implementation Priority:

Due to the prevalence of high nitrate concentrations in the Arkansas River downstream of a major municipal WWTP, this TMDL focuses on reducing nitrate in the City of Wichita WWTP (Lower Arkansas River Plant) effluent. Due to the need to reduce the high nutrient loads in the Arkansas River, this TMDL will be **High Priority** for implementation.

Nutrient Reduction Framework Priority Ranking:

This watershed lies within the Middle Arkansas – Slate Subbasin (HUC8 11030013), which is among the top sixteen HUC8s targeted for state action to reduce nutrients.

Priority HUC12s:

This watershed is comprised of one HUC12 (110300130106) which is assigned the priority status for restoration.

5. IMPLEMENTATION

Desired Implementation Activities:

1. Make operational changes in municipal WWTP to reduce nitrate load.
2. Facilitate wastewater reuse for treated municipal wastewater.
3. Monitor nitrate concentrations in groundwater discharges to prevent discharges of increasing nitrate concentrations.
4. Renew state and federal permits and inspect permitted facilities for permit compliance.
5. Improve riparian conditions along stream systems by installing grass and/or forest buffer strips along the stream and drainage channels in the watershed.
6. Implement and maintain conservation farming practices—including conservation tilling, contour farming, and no-till farming to reduce runoff and cropland erosion of agricultural areas in the watershed.
7. Perform extensive soil testing to ensure excess nitrogen is not unnecessarily applied.

8. Ensure labeled application rates for chemical fertilizers are followed to reduce runoff.
9. Implement nutrient management plans and ensure that land-applied manure is properly managed to reduce runoff.

Implementation Program Guidance:

NPDES and State Permits – KDHE:

a. Continue to monitor influent to and effluent from the permitted discharging WWTP, encourage wastewater reuse and irrigation disposal, and ensure compliance and proper operation of WWTP to control nitrate in wastewater effluent.
b. Establish permit limits after 2022, with the initial implementation of goals and appropriate schedules of compliance for permits issued prior.
c. Implement SMPs and BMPs in the City of Wichita and Sedgwick County to reduce pollutant loads to the maximum extent practicable.
d. Establish nutrient reduction practices among urban homeowners to manage chemical application on lawns and gardens through aforementioned SMPs.
e. Manure management plans, detailing proper land application rates and practices, will be implemented to prevent runoff of applied manure.
f. Manage the WLA for the watershed to accommodate population growth as needed.

Nonpoint Source Pollution Technical Assistance – KDHE:

a. Support Section 319 implementation projects for nutrient management through reduction of nitrate runoff from agricultural activities.
b. Provide technical assistance on practices to establish vegetative buffer strips.
c. Support implementation efforts of the Lower Arkansas/River City Watershed Restoration and Protection Strategy (WRAPS) and incorporate long term objectives of this TMDL into their 9-element watershed plan.

Water Resource Cost Share and Nonpoint Source Pollution Control Program – Kansas Department of Agriculture-Division of Conservation (KDA-DOC):

a. Apply conservation farming practices—including no-till, terraces, and contours—and/or erosion control structures, including sediment control basins and constructed wetlands.
b. Provide sediment control practices to minimize erosion and sediment transport from cropland and grassland in the watershed.
c. Encourage residue management to reduce nitrogen loss to volatilization or runoff transport from croplands in the watershed.
d. Implement manure management plans.

Riparian Protection Program – KDA-DOC:

a. Establish or re-establish natural riparian systems, including vegetative filter strips and streambank vegetation.

b. Develop riparian restoration projects along targeted stream segments, especially those areas with baseflow.
c. Promote wetland construction to reduce runoff and assimilate loadings.
d. Coordinate riparian management within the watershed and develop riparian restoration projects.

Buffer Initiative Program – KDA-DOC:

a. Install grass buffer strips near streams.
b. Leverage Conservation Reserve Enhancement Programs to hold riparian land out of production.

Extension Outreach and Technical Assistance – Kansas State University:

a. Educate agricultural producers on sediment, nutrient, and pasture management.
b. Provide technical assistance on buffer strip design and minimizing cropland runoff.
c. Encourage annual soil testing to determine capacity of field to hold nitrogen.
d. Educate residents, landowners, and watershed stakeholders about nonpoint source pollution.
e. Promote and utilize the WRAPS efforts for pollution prevention, runoff control, and resource management.

Timeframe for Implementation:

Reduction strategies for the municipal WWTP should be evaluated by 2020 with subsequent planning, design, and construction of any necessary enhanced treatment initiated by the next permit starting in 2022. Urban stormwater and rural runoff management should expand in 2018 to ensure nutrients are addressed. Pollutant reduction practices should be installed within the priority subwatersheds before 2023 with follow-up implementation over 2023-2028.

Targeted Participants:

The primary participant for implementation is the City of Wichita WWTP (Lower Arkansas River Plant; KS0043036). Agricultural operations immediately adjacent to the Arkansas River and its tributaries will be encouraged to implement appropriate practices to further reduce nitrogen loads, as well. Watershed coordinators, technical staff of the WRAPS group, conservation district personnel, and county extension agents should coordinate to assess possible nutrient sources adjacent to streams. Implementation activities to address nonpoint sources should focus on those areas with the greatest potential to impact nutrient concentrations adjacent to the river.

Targeted activities to focus attention toward include:

1. Development of high-density urban and residential areas in proximity to streams and tributaries.
2. Informing urban residents on fertilizer and waste management through their respective SMPs.

3. Denuded riparian vegetation and poor riparian areas along the stream.
4. Conservation compliance on highly erodible areas.
5. Unbuffered cropland adjacent to the stream.
6. Total row crop acreage and gully locations.
7. No till or residue management on cropland.

Milestone for 2024:

Advancement of necessary and appropriate measures to decrease nitrate effluent in the City of Wichita WWTP (Lower Arkansas River Plant; KS0043036) should be implemented by 2024. At that time, nitrate data from the Arkansas River at Derby (SC281 and SB281) should show indication of declining nitrate concentrations relative to the pre-2017 data, particularly during normal and below normal flow conditions.

Delivery Agents:

The primary delivery agents for program participation will be Sedgwick County, the City of Wichita, KDHE, and the Lower Arkansas/River City WRAPS.

Reasonable Assurances:

Authorities:

The following authorities may be used to direct activities in the watershed to reduce pollution:

1. K.S.A. 65-164 and 165 empowers the Secretary of KDHE to regulate the discharge of sewage into the waters of the state.

2. K.S.A. 65-171d empowers the Secretary of KDHE to prevent water pollution and to protect the beneficial uses of the waters of the state through required treatment of sewage and established water quality standards and to require permits by persons having a potential to discharge pollutants into the waters of the state.

3. K.S.A. 2002 Supp. 82a-2001 identifies the classes of recreation use and defines impairment for streams.

4. K.A.R. 28-16-69 through 071 implements water quality protection by KDHE through the establishment and administration of critical water quality management areas on a watershed basis.

5. K.S.A. 2-1915 empowers the State Conservation Commission to develop programs to assist the protection, conservation, and management of soil and water resources in the state, including riparian areas.

6. K.S.A. 75-5657 empowers the State Conservation Commission to provide financial assistance for local project work plans developed to control nonpoint source pollution.

7. K.S.A. 82a-901, et. seq. empowers the Kansas Water Office to develop a state water plan directing the protection and maintenance of surface water quality for the waters of the state.

8. K.S.A. 82a-951 creates the State Water Plan Fund to finance the implementation of the Kansas Water Plan, including selected WRAPS.

9. The Kansas Water Plan provides the guidance to state agencies to coordinate programs intent on protecting water quality and to target those programs to geographic areas of the state for high priority in implementation.

Funding:

The State Water Plan annually generates $12-13 million and is the primary funding mechanism for implementing water quality protection and pollution reduction activities in the state through the Kansas Water Plan. The state water planning process, overseen by the Kansas Water Office, coordinates and directs programs and funding toward watershed and water resources by priority. Typically, the state allocates at least 50% of the fund to programs supporting water quality protection. This watershed and its TMDL are located within a **High Priority** area and should receive support for pollution abatement practices that lower the loading of sediment and nutrients.

Effectiveness:

Use of Biological Nutrient Removal technology in WWTPs has been well established to reduce nutrient levels, including nitrate, in wastewater. Agricultural nutrient control has been proven effective through conservation tillage, contour farming, and use of grass waterways and buffer strips; additionally, the proper implementation of comprehensive livestock waste management.

6. MONITORING

KDHE will continue to monitor for nitrate at SC281, Arkansas River at Derby. Biological monitoring will also continue at SB281 to assess compliance with the narrative nutrient criteria in the river. Based on the sampling data, the status of the watershed will be re-evaluated during the 303(d) listing process in 2024.

7. FEEDBACK

Public Notice:

An active website is established at http://www.kdheks.gov/tmdl/planning_mgmt.htm to convey information to the public on the general establishment of TMDLs and specific TMDLs for the Lower Arkansas River Basin. This TMDL was posted to this site on April 5, 2018 for public review.

Public Hearing:

A public hearing on this TMDL was held on April 27, 2018 in Wichita, Kansas to receive public comments. No comments were received.

Milestone Evaluation:

In 2024, evaluation will be made as to the degree of implementation that occurred within the watershed. Subsequent decisions will be made through consultation with local stakeholders and any active WRAPS group in the watershed regarding implementation of nonpoint source reduction strategies and development of additional implementation strategies for the watershed.

Consideration for 303(d) Delisting:

The Arkansas River segments covered by this TMDL will be evaluated for delisting under Section 303(d) based on the monitoring data from 2018-2029. Therefore, the decision for delisting will ensue when preparing for subsequent 303(d) lists. Should modifications be made to the applicable water quality criteria during the implementation period, consideration for delisting, desired endpoints of this TMDL, and implementation activities may be adjusted accordingly.

Incorporation into the TMDL Vision Process, Water Quality Management Plan, and the Kansas Water Planning Process:

Under the current version of the Kansas TMDL Vision Process, the next anticipated revision of this TMDL would come in 2022. The revision will emphasize implementation of WRAPS activities and further reduction of nutrients in wastewater discharged by NPDES facilities. At that time, incorporation of this TMDL will be made into the WRAPS plan. Recommendations for this TMDL will be considered in the Kansas Water Plan implementation decisions under the State Water Planning Process for fiscal years 2018-2026.

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REFERENCES

Electric Power Research Institute provided by U.S. Environmental Protection Agency, 2017, State-by-state septic failure rate survey, Accessed online at http://it.tetratechffx.com/steplweb/Faq.htm#Q4.

Graham, J.L., Stone, M.L., Rasmussen, T.J., Foster, G.M., Poulton, B.C., Paxson, C.R., and Harris, T.D., 2014, Effects of wastewater effluent discharge and treatment facility upgrades on environmental and biological conditions of Indian Creek, Johnson County, Kansas, June 2004 through June 2013: U.S. Geological Survey Scientific Investigations Report 2014–5187, 78 p., Accessed online at http://dx.doi.org/10.3133/sir20145187.

Guilliams, D., 2016, The Big Ditch: The Wichita-Valley Center Flood Control Project, Fairmount Folio: Journal of History, Accessed online September 2017 at http://journals.wichita.edu/index.php/ff/article/view/37/44.

Homer, C.G., Dewitz, J.A., Yang, L., Jin, S., Danielson, P., Xian, G., Coulston, J., Herold, N.D., Wickham, J.D., and Megown, K., 2015, Completion of the 2011 National Land Cover Database for the conterminous United States-Representing a decade of land cover change information, Photogrammetric Engineering and Remote Sensing, v. 81, no. 5, p. 345-354, Accessed online at https://www.mrlc.gov/nlcd2011.php.

Juracek, K., 2000, Estimation and comparison of potential runoff-contributing areas in Kansas using topographic, soil, and land-use information: U.S. Geological Survey Water-Resources Investigations Report 00-4177, 62 p., Accessed online at https://ks.water.usgs.gov/pubs/reports/wrir.99-4242.html.

Kansas Department of Health and Environment, Bureau of Water, 2013, Kansas Surface Water Register, 74 p., Accessed online at http://www.kdheks.gov/befs/resourcespublications.html.

Kansas Department of Health and Environment, Bureau of Water, 2016, 303(d) list of all impaired/potentially impaired waters, 90 p., Accessed online at http://www.kdheks.gov/tmdl/methodology.htm.

Kansas Department of Health and Environment, Bureau of Water, 2015, Kansas Surface Water Quality Standards, 72 p., Accessed online at http://www.kdheks.gov/tmdl/kswqs.htm.

Kansas Geological Survey, 2013, State geologic map of Kansas-alluvial aquifer, Accessed online at https://catalog.data.gov/dataset/alluvial-aquifer.

Kansas Water Office, 2002, Population estimates and projections for cities by county by selected year.

National Oceanic and Atmospheric Administration, 2017, Daily summary observations, Accessed online at https://www.ncdc.noaa.gov/.

National Oceanic and Atmospheric Administration, 2008, The Halloween flood of 1998, Accessed online at https://www.weather.gov/ict/halloweenflood.

Perry, C.A., Wolock, D.M., and Artman, J.C., 2004, Estimates of flow duration, mean flow, and peak-discharge frequency values for Kansas stream locations: U.S. Geological Survey Scientific Investigations Report 2004-5033, 651 p., Accessed online at https://ks.water.usgs.gov/stream flow-statistics.

Soil Survey Staff, Natural Resources Conservation Service, U.S. Department of Agriculture, State Soil Geographic Database (STATSGO), Accessed online at https://www.nrcs.usda.gov.

Townsend, M.A., Macko, S.A., and Young, D.P., 2001, Distribution and sources of nitrate-nitrogen in Kansas groundwater, The Scientific World, p. 216-222, Accessed online at https://www.hindawi.com/journals/tswj/2001/816560/abs/.

U.S. Census Bureau, 2010, 2010 Census urban and rural classification, Accessed online at https://www.census.gov/geo/reference/ua/urban-rural-2010.html.

U.S. Census Bureau, 2010, Fact Finder, Accessed online at https://factfinder.census.gov/faces/nav/jsf/pages/community_facts.xhtml?src=bkmk.

U.S. Department of Agriculture, 2012, Census of agriculture, Accessed online at https://www.agcensus.usda.gov/Publications/2012/Full_Report/Census_by_ State/ Kansas/.

U.S. Environmental Protection Agency, 2010, Final report on acute and chronic toxicity of nitrate, nitrite, boron, manganese, fluoride, chloride, and sulfate to several aquatic animal species, Accessed online at https://nepis.epa.gov.

U.S. Environmental Protection Agency, 2017, Spreadsheet Tool for Estimating Pollutant Load (STEPL), Accessed online at http://it.tetratechffx.com/steplweb/default.htm.

U.S. Geological Survey, 2017, USGS WaterWatch, Accessed online at http://waterwatch.usgs.gov.